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LOCK CULVERT VALVE LOSS COEFFICIENTS. HYDRAULIC LABORATORY INVE--ETC(U)
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TECHNICAL REPORT HL-81-10

LOCK CULVERT VALVE LOSS COEFFICIENTS

Hydraulic Laboratory Investigation

by

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September 1981

Final Report

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Prepared for Office, Chief of Engineers, U. S. Army
Washington, D. C. 20314

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REPORT DOCUMENTATION PAGE		READ INSTRUCTIONS BEFORE COMPLETING FORM
1. REPORT NUMBER Technical Report HL-81-10	2. GOVT ACCESSION NO. AD-A107 735	3. RECIPIENT'S CATALOG NUMBER
4. TITLE (and Subtitle) LOCK CULVERT VALVE LOSS COEFFICIENTS; Hydraulic Laboratory Investigation		5. TYPE OF REPORT & PERIOD COVERED Final report
		6. PERFORMING ORG. REPORT NUMBER
7. AUTHOR(s) Glenn A. Pickering		8. CONTRACT OR GRANT NUMBER(s)
9. PERFORMING ORGANIZATION NAME AND ADDRESS U. S. Army Engineer Waterways Experiment Station Hydraulics Laboratory P. O. Box 631, Vicksburg, Miss. 39180		10. PROGRAM ELEMENT, PROJECT, TASK AREA & WORK UNIT NUMBERS
11. CONTROLLING OFFICE NAME AND ADDRESS Office, Chief of Engineers U. S. Army Washington, D. C. 20314		12. REPORT DATE September 1981
		13. NUMBER OF PAGES 46
14. MONITORING AGENCY NAME & ADDRESS(if different from Controlling Office)		15. SECURITY CLASS. (of this report) Unclassified
		15a. DECLASSIFICATION/DOWNGRADING SCHEDULE

16. DISTRIBUTION STATEMENT (of this Report)

Approved for public release; distribution unlimited.

17. DISTRIBUTION STATEMENT (of the abstract entered in Block 20, if different from Report)

18. SUPPLEMENTARY NOTES

Available from National Technical Information Service, 5285 Port Royal Road, Springfield, Va. 22151.

19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Culverts
Navigation locks
Pressure measurement
Valves

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

This report presents results of tests that were conducted to determine valve loss coefficients to use in predicting pressures downstream from navigation lock culvert valves. Reliable prediction of these pressures is needed so that a valve can be sited to prevent cavitation either by submergence or self-aeration with air vents. Tests were conducted with various culvert roof expansions beginning at several locations downstream from the lock culvert valve to determine the effect of the expansion on valve loss coefficients.

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PREFACE

The study reported herein was conducted under the sponsorship of the Office, Chief of Engineers (OCE), U. S. Army, as a Civil Works Investigation Work Unit 31479, in the Locks and Dam (Navigation Hydraulics) Research Program. The study was authorized in FY 77. Tests were conducted in the Hydraulics Laboratory of the U. S. Army Engineer Waterways Experiment Station (WES) under the general supervision of Messrs. H. B. Simmons, Chief of the Hydraulics Laboratory, and J. L. Grace, Jr., Chief of the Hydraulic Structures Division, and under the direct supervision of Mr. G. A. Pickering, Chief of the Locks and Conduits Branch. Tests were conducted by Messrs. D. B. Murray, J. H. Ables, Jr., J. F. George, C. L. Dent, T. E. Murphy, Jr., and H. S. Headley II. This report was prepared by Mr. Pickering.

Technical monitors of the Locks and Dams (Navigation Hydraulics) Research Program during the course of the investigation and the preparation and publication of this report were Messrs. S. B. Powell and B. McCartney (OCE).

Commanders and Directors of WES during the conduct of the study and the preparation and publication of this report were COL John L. Cannon, CE, COL Nelson P. Conover, CE, and COL Tilford C. Creel, CE. Techincal Director was Mr. F. R. Brown.

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CONTENTS

CONVERSION FACTORS, U. S. CUSTOMARY TO METRIC (SI)
UNITS OF MEASUREMENT

U. S. customary units of measurement used in this report can be converted to metric (SI) units as follows:

Multiply	By	To Obtain
cubic feet per second	0.02831685	cubic metres per second
feet	0.3048	metres
feet per second	0.3048	metres per second
feet per second per second	0.3048	metres per second per second

LOCK CULVERT VALVE LOSS COEFFICIENTS

Hydraulic Laboratory Investigation

PART I: INTRODUCTION

Background

1. Prevention of cavitation downstream from high-lift lock culvert valves has become an increasingly difficult problem for designers as lifts have increased to values greater than 100 ft.* High velocities and low pressures are induced as flow accelerates immediately downstream from the valves during the valve opening period. In some instances, the local flow acceleration is sufficient to lower the local pressure to the vapor pressure of water and form cavities within the flow. These cavities collapse rapidly or implode either in the water or against the downstream boundaries as they enter the increased pressure that results from the decreased velocity of flow as it expands and is decelerated in the culvert downstream of the valve. This has resulted in lock masters reporting loud pounding noises indicating cavitation implosions within the flow. In some instances, these booms have been violent enough to shake the lock walls and break windows. The implosion of the cavities against solid boundaries results in rapid pitting or damage to valves and appurtenances and to the concrete culverts.

2. In early designs, pressures low enough to cause cavitation were avoided by submerging the culvert at the location of the valve so that the pressure gradient was maintained above the top of the culvert. However, as lifts increased, it became increasingly costly to provide adequate submergence. Through prototype tests at some of the high-lift locks on the Columbia River it was found that admitting a controlled amount of air into the culverts at each valve virtually eliminated the

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* A table of factors for converting U. S. customary units of measurement to metric (SI) units is presented on page 3.

pounding noises. Air was drawn through a vent placed downstream from the valve into the culvert system during the valve opening period, was entrained as small bubbles in the highly turbulent flow, and emerged in the lock chamber so entrained that it merely caused the water to look milky. It was concluded that the air cushioned the collapse of the large cavities, eliminated shock pressures, and thus eliminated the pounding noises. This procedure allowed the culverts to be placed at a much higher elevation. Several locks have been constructed by the Corps using this procedure and no operation difficulties or hazardous conditions have been reported where pressures on the culvert roof were low enough to draw air during the valve opening period.

3. Through model tests of various locks it was found that expanding the culvert roof upward downstream from the valve would increase pressures on the roof of the culvert just downstream from the valve. Also, in one series of model tests for the Lower Granite Lock* it was found that the location of the expansion with respect to the valve directly affected the pressure on the roof of the culvert in the area immediately downstream from the valve as shown in Plate 1.

Purpose of Investigation

4. The use of expansions downstream from culvert valves is a very practical means of controlling the pressures and allowing the valves to be set at a more economical elevation. However, the limited amount of available test data was not adequate to predict the precise effect of the degree of expansion and location of the expansion on pressures and loss coefficients. Thus, systematic tests were needed to determine these factors. Also, it was expected that the tests would determine the exact location where minimum pressure occurs during a valve opening period.

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* U. S. Army Engineer Division, North Pacific, CE. 1979 (Sep). "Navigation Lock for Lower Granite Dam, Snake River, Washington; Hydraulic Model Investigation," Technical Report No. 126-1, Division Hydraulic Laboratory, Bonneville, Oreg.

PART II: TEST FACILITY

Description

5. The test facility (Figure 1) consisted of a headbay, conduit, valve well, reverse tainter valve, and tailbay. The upstream conduit was 47 ft long with a straight length of 17 ft upstream from the valve well and the downstream conduit was 14 ft long. A layout and details of the facility are shown in Plate 2. The culvert and valve well were constructed of plastic, and the valve was made from sheet metal.

Appurtenances

6. Water was supplied to the facility through a circulating system. Discharges were measured by a venturi meter and an orifice meter installed in the flow lines. Piezometers were used to measure pressures, and an adjustable tailgate was used to regulate the downstream pool elevation (lock chamber elevation).

7. The instrumentation and control system provided for operation of the culvert tainter valve by means of a programmable d-c motor. The position of the valve opening was indicated by a linear potentiometer. The cam and signal plot could be drawn to carefully control the valve position as a function of time.

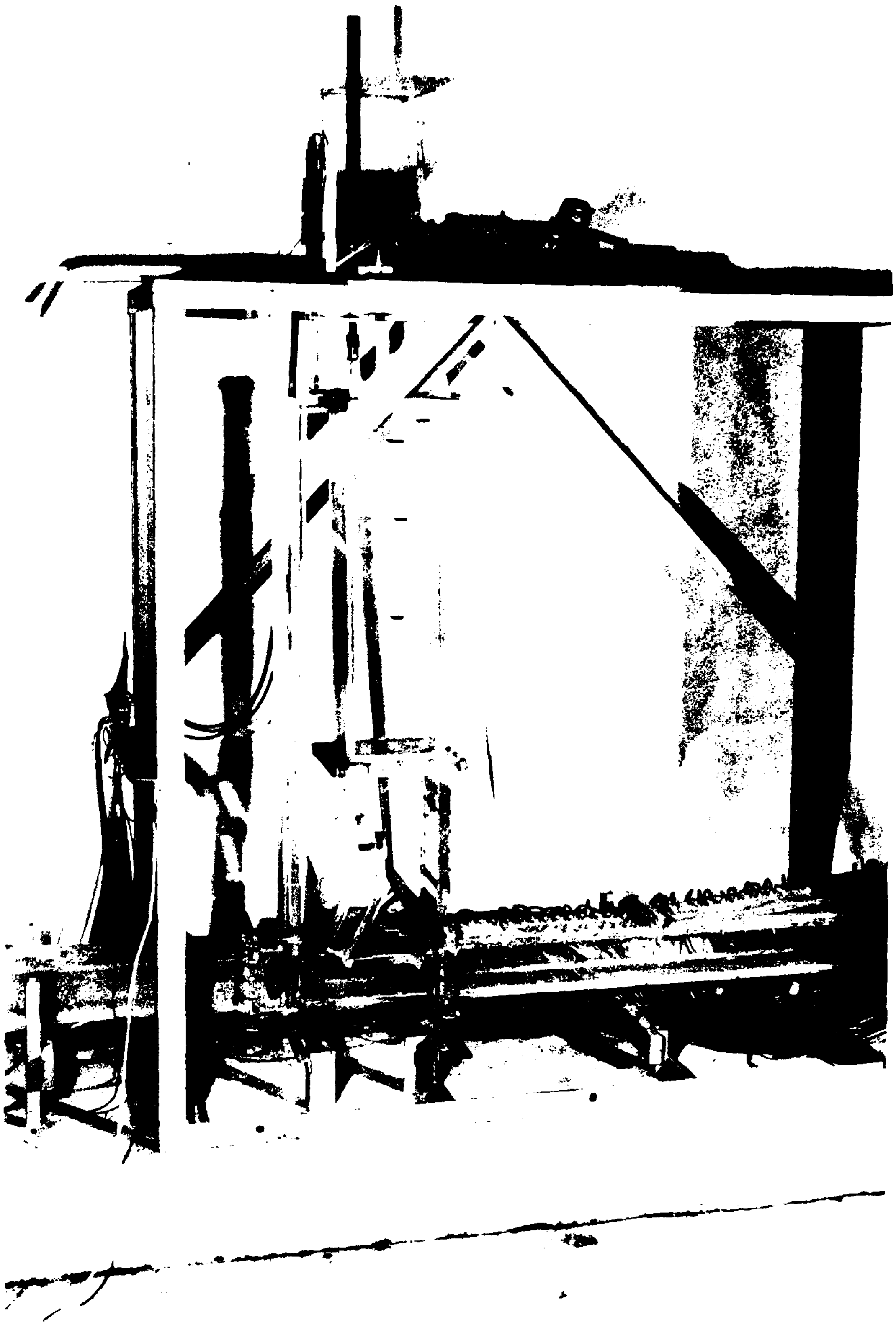

Figure 1. Test facility

PART III: TESTS AND RESULTS

8. Pressures downstream from lock filling valves are a function of the valve loss coefficients, K_v , along with other factors. The valve loss coefficient used in this study refers to the total head loss at the valve which includes that due to the valve well, the valve, and the culvert expansion. This study was concerned primarily with the effect of culvert expansions downstream from the valve on K_v . The valve loss coefficient is defined by the following equation.

$$K_v = \frac{\Delta E}{V_1^2/2g} \tag{1}$$

where

K_v = valve loss coefficient

ΔE = energy loss of the valve, ft

V_1 = average velocity in the culvert upstream from the valve, fps

g = acceleration due to gravity, ft/sec^2

9. All of the tests reported herein were conducted with a vertically framed tainter gate as shown in Engineer Manual 1110-2-1610, "Hydraulic Design of Lock Culvert Valves." Although the valve loss coefficients reported herein would probably be slightly different with the other types of reverse tainter valves shown in the referenced manual, the conclusions drawn from these tests would be the same regardless of the type of valve used.

Test Procedure

10. Each test consisted of setting a specific valve opening, discharge, upper pool elevation, and lower pool elevation and then recording pressures as indicated by piezometers installed throughout the test section. At least three tests were made with each valve position with either different discharges or different lower pool (lock chamber) elevations. Data were plotted for each test as shown in Plate 3. Slopes of the pressure grade lines in the culverts upstream and downstream

from the valve section were extended to the valve well to determine the head loss, ΔH , at that section. Average velocities in the sections of culvert upstream and downstream from the roof expansion, V_1 and V_3 , respectively, were determined from the known cross-sectional areas and discharge. By adding the difference in velocity head in the two sections, $V_1^2/2g - V_3^2/2g$, to the head loss the total energy loss at the valve section, ΔE , was determined. The valve loss coefficient was then computed using Equation 1 shown in paragraph 8 above. Results for the various test runs along with pertinent boundary conditions for each run are shown in Table 1.

Initial Tests

11. Initial tests were conducted with a culvert of constant cross section 0.56 ft by 0.56 ft upstream, through, and downstream of the valve (type 1 design, Plate 4). Data obtained with this unexpanded culvert formed the basis for comparison with other designs tested and, also, for comparison with prototype data since extensive data were available from McNary Lock which has unexpanded culverts (Plate 5). Pressures measured with the type 1 design are shown in Table 2.

12. Data obtained were used to compute valve loss coefficients as indicated in paragraph 10. These coefficients are shown in Table 1 and are plotted in Plate 5. Points from the curve in Hydraulic Design Chart 534-1 are also shown for comparison. These data are very close and the agreement between the experimental and prototype values is excellent.

13. The assumption was made that energy loss between the valve well and the vena contracta is negligible. Thus, the velocity head in the vena contracta must equal the distance between the energy grade line in the valve well and the minimum pressure on the roof of the culvert downstream from the valve. On this assumption, velocities in the vena contracta and contraction coefficients for the valve were determined. Contraction coefficients agreed closely with those used in lock filling and emptying computations in Engineer Manual 1110-2-1610 as shown in Plate 6 for conditions of no culvert roof expansion. The expansions

tested in this study did not influence the contraction coefficient.

Culvert Expansion at Valve

14. After the base data were obtained, tests were conducted with culvert height expansions from 0.56 to 0.88 ft (type 2 design, Plate 4) and from 0.56 to 0.72 ft (type 4 design, Plate 4) beginning immediately downstream from the valve. The roof of the culvert was sloped up 1V on 10H in all designs. Pressures obtained during these tests are shown in Tables 3 and 4. Valve loss coefficients are shown in Table 1 and are plotted in Plate 7. As shown in this plot, there is greater energy loss through the expanded culverts, particularly in the 50 to 70 percent range of valve openings. With identical valve openings and equal discharge, pressure drops are the same regardless of the roof expansion, since the expansions did not influence the contraction coefficient. It is postulated that if the entire system (rather than the valve, as in these tests) controls flow, the pressure drops would be the same; but the absolute pressure downstream of the valve would be significantly higher. The test results indicate that the maximum negative pressure downstream from the valve is less with an expanded culvert, not because of flow circulation as had been hypothesized but because the fully expanded flow velocities (thus, discharges) are less in the downstream culvert, particularly through the range of valve openings that result in minimum pressure. With relatively small valve openings, the energy loss is relatively large due to expansion and deceleration of flow. With the larger valve openings, the change in velocities and energy loss are minor due to only minor contraction and expansion of flow.

Culvert Expansion Downstream from Valve

15. Tests were conducted to determine the effect of the position of the beginning of the roof expansion on valve loss coefficients. All of these tests were conducted with a roof expansion of 1V on 10H from a height of 0.56 to 0.88 ft. Expansion started at distances downstream

from the valve of 0.28 ft (type 3 design), 0.56 ft (type 5 design), 1.68 ft (type 6 design), 2.24 ft (type 8 design), and 3.64 ft (type 7 design). All of these designs are shown in Plate 4.

16. Pressures measured during these tests are shown in Tables 5-9. Valve loss coefficients computed from these data and the data from the types 1 and 2 designs are shown in Table 1 and are plotted in Plate 8. These data show valve loss coefficients to be essentially the same with no roof expansion (type 1) and with roof expansions beginning 4.0 valve heights (type 8) and 6.5 valve heights (type 7) downstream from the valve. A plot showing the effect of the beginning of the roof expansion on valve loss coefficients is shown in Plate 9. It appears from this plot that the effect of the position of the roof expansion on valve loss coefficients varies slightly with the valve opening. For each valve opening there is a critical value for the distance to the beginning of the expansion, beyond which there is no change in the valve loss coefficient. Expansions that start downstream from these critical locations would have no influence on valve loss coefficients. This critical location is about 3.5 to 4.5 valve heights downstream of the valve in the range of openings where minimum pressure occurs during a filling cycle. This is in reasonable agreement with the Lower Granite results (Plate 1) which show effects within 5 valve heights.

Location of Minimum Pressure

17. Pressures were measured at various elevations and distances downstream from the valve to determine the location where minimum pressure occurs. These tests were conducted to assist the designer in locating the air vents downstream from the valve. The culvert expansions had little effect on the location of the minimum pressure. Isopiestic lines obtained with valve openings of 40, 50, 60, 70, and 80 percent are shown in Plate 10. These data are in dimensionless form and are averages from several tests conducted with the types 1 and 8 designs. The following was used to convert the data to a dimensionless form.

$$\frac{P_u - P}{V_1^2/2g}$$

where

P_u = pressure immediately upstream from valve well, ft

P = pressure at some point downstream from valve, ft

V_1 = average velocity in culvert upstream from valve, fps

g = acceleration due to gravity, ft/sec^2

These data indicate that minimum pressures occur near the top of the culvert. The distance downstream from the valve where these minimum pressures occur varies with the valve opening and moves upstream as the valve is opened. As shown in Plate 10, the location of minimum pressure at the roof of the culvert with the valve open 60 percent is between 0.5 and 1.0 valve heights downstream from the valve. Thus, the common practice of placing the air vents in the roof of the culvert about 0.5 valve heights downstream from the valve is satisfactory, although the vents could be placed farther downstream if necessary.

PART IV: DISCUSSION AND CONCLUSIONS

18. Accurate valve loss coefficients, particularly in the range of valve openings between 50 and 70 percent, are imperative for close prediction of minimum pressure downstream from navigation lock culvert valves. Reliable prediction of these pressures is needed so that a valve can be sited to prevent cavitation either by submergence or self-aeration with air vents. The valve loss coefficients determined in these tests unquestionably are more accurate than can be determined by picking values from filling curves only. Thus, it is recommended that in analysis of prototype data and in predictions of performance of future locks these coefficients be used.

19. The maximum negative pressure downstream from the valve was found to be less with an expanded culvert. The negative pressure was reduced because the valve loss coefficients were larger with the expanded culvert, and thus, the discharges were less through the range of valve openings that result in maximum negative pressure. The valve loss coefficients determined in this study can be used to determine the effect of culvert expansions on pressure downstream from the valve with expansions up to 57 percent of the valve height. The 57 percent expansion was based on the Lower Granite Lock which is the largest expansion constructed to date. Also, this was considered to be near the upper limit from a practical standpoint.

20. The study showed that culvert expansions that begin 4.5 valve heights or more downstream from the valve have no effect on the valve loss coefficients for valve openings of 30 percent or greater. Expansions beginning within 4.5 valve heights of the valve increased loss coefficients linearly as the expansion was placed closer to the valve. This agrees reasonably well with data obtained from a previous model of Lower Granite Lock which shows minimum pressure decreasing linearly as the expansion was moved downstream until it reached a distance of 5 valve heights.

21. In design of future locks if it becomes necessary to expand the culverts to reduce friction losses in the filling system or for

structural reasons, and the expansion is not needed to reduce negative pressures for optimum location of the valve, then the expansion should not begin within 4.5 valve heights downstream from the valve. If the expansion is needed to reduce negative pressures, but the amount of expansion is greater than that required to obtain optimum pressures with the expansion beginning immediately downstream from the valve, the expansion can be moved some distance downstream from the valve to obtain optimum pressures. The valve loss coefficients shown in this report can be used to determine this distance.

22. It was concluded that the contraction coefficient is independent of culvert roof expansions when the valve is controlling the discharge as it was in these tests. The pressure drop from the grade line in the valve well to the minimum pressure downstream from the valve was dependent upon both the contraction coefficient and the discharge. Thus, expansions influenced this pressure drop only because they influenced the discharge.

23. Minimum pressure downstream from the valve occurred at or near the top of the culvert. The location of this pressure varied with the valve opening and moved upstream as the valve was opened. The minimum pressure was located between 1.0 to 0.5 valve heights downstream from the valve with valve openings in the range of 50 to 70 percent open where minimum pressure usually occurs. Thus, air vents should be located in the roof of the culvert at a distance of 1.0 to 0.5 culvert heights downstream from the valve, preferably 0.5 culvert heights, since the lowest pressure occurs at that location with the valve near a 60 percent opening.

24. All of the data shown in this report were obtained with a vertically framed (Holt-type) valve, since it is the most commonly used type. Valve loss coefficients and contraction likely are different for other types of valves, such as a double skin-plate valve. Although the value of the coefficients would be different, the conclusions concerning the effect of expansion and location of the expansion on loss coefficients and location of minimum pressure should be the same.

25. The test facility used to obtain data to determine the valve

loss coefficients did not include the culvert intake or distribution culverts and ports of the filling and emptying system. Also, the tests were conducted with constant upper and lower pool elevations and valve openings. Thus, the effective inertia of a prototype filling and emptying system was not reproduced. However, by using the valve loss coefficients determined in this study, along with other loss coefficients for the culvert intakes, friction, and exit manifold in the CORPS* H5320 computer program, accurate hydraulic data such as pressures and lock filling and emptying times can be obtained.

26. Future studies with a model of an entire bottom longitudinal filling and emptying system would be very beneficial in determining other loss coefficients such as the intakes to the culverts, in the distribution system and at the outlet manifolds.

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* Conversationally Oriented Real-Time Program Generating System (CORPS) Computer Program H5320, "Lock Filling and Emptying Symmetrical Systems." Available from: WES Library, U. S. Army Engineer Waterways Experiment Station, CE, P. O. Box 631, Vicksburg, Miss. 39180, and from several CE computer systems.

Table 1

Valve Loss Coefficients and Hydraulic Conditions

Type Culvert Expansion	Valve Opening Percent	Run No.	Headwater Elevation	Lock Chamber Elevation	Discharge CFS	Valve Loss Coefficient
1	20	332	5.750	2.360	0.60	56.14
	20	333	5.230	1.870	0.60	55.79
	20	334	4.710	1.190	0.60	58.42
	30	198	4.864	1.232	1.00	19.49
		201	5.468	1.780	1.00	20.25
		202	5.852	2.248	1.00	19.68
		197	5.804	1.200	1.14	19.51
		199	5.312	1.240	1.08	20.00
	40	194	3.672	1.200	1.13	9.16
		196	4.340	1.840	1.13	9.16
		195	4.920	2.384	1.13	9.26
		155	5.608	1.160	1.54	8.90
		156	4.212	1.204	1.27	8.55
	50	175	4.440	1.136	1.68	4.30
		176	4.932	1.808	1.68	4.13
		177	5.552	2.436	1.68	4.04
		157	3.928	1.324	1.54	4.01
		184	4.388	1.208	1.65	4.42
	60	167	5.016	1.200	2.08	2.08
		168	5.108	1.800	2.08	1.92
		169	5.632	2.400	2.08	1.92
		174	4.892	1.492	2.08	2.08
		179	5.092	1.552	2.08	2.15
		163	5.416	1.320	2.28	2.11
		159	5.584	1.312	2.35	2.06
	70	172	5.800	2.152	2.48	0.94
		171	5.420	1.800	2.48	0.91
		178	5.380	1.600	2.48	1.00
		170	4.920	1.200	2.48	0.96
		161	5.560	1.268	2.68	0.92
		160	4.572	1.296	2.35	0.95
	80	320	4.730	1.220	2.61	0.344
		321	5.190	1.810	2.61	0.409
		322	5.770	2.440	2.61	0.307
		323	4.910	1.300	2.72	0.368
		324	5.660	1.240	3.00	0.324
	90	325	5.820	2.290	2.80	0.097
		326	5.450	1.410	2.80	0.097
		327	4.820	1.170	2.80	0.097
		328	5.860	1.180	3.00	0.106
	100	329	5.770	2.410	2.76	0.042
	100	330	5.220	1.770	2.76	0.050
	100	331	5.780	1.800	2.96	0.043
	30	208	3.880	1.172	0.80	22.97
		209	4.276	1.808	0.80	22.38
		210	4.872	2.420	0.80	21.98
		211	4.804	1.220	0.96	21.51
		212	5.104	1.212	1.00	22.41
		213	5.580	1.300	1.08	21.09
		214	5.680	1.832	1.00	21.20
2	40	215	3.972	1.200	1.13	11.34
	40	216	4.572	1.828	1.13	11.39
	40	217	5.172	2.400	1.13	10.99
	40	218	5.180	1.224	1.38	10.99
	50	219	5.752	2.412	1.68	1.32
	50	220	5.400	1.816	1.68	1.39
	50	221	4.660	1.200	1.68	1.42
	60	223	5.872	2.420	2.10	2.93
	60	224	5.216	1.828	2.10	2.83
	60	226	4.772	1.204	2.10	2.99
	70	227	5.888	2.400	2.48	1.52
	70	228	5.348	1.840	2.48	1.51
	70	229	4.872	1.240	2.48	1.56
	80	230	5.428	2.448	2.61	0.60
	80	231	4.960	1.792	2.61	0.61
	80	232	4.248	1.208	2.61	0.60
	90	233	5.396	2.396	2.82	0.27
	90	234	4.828	1.788	2.82	--
	100	235	5.408	2.408	2.93	0.11
	100	236	4.820	1.812	2.93	0.13
3	30	240	5.088	1.200	1.00	1.98
	30	241	5.680	1.760	1.00	2.05
	30	242	3.960	1.400	0.80	2.02
	40	243	3.950	1.220	1.13	1.76
		244	4.565	1.885	1.13	1.74
		245	5.080	2.400	1.13	1.75
		246	5.190	1.200	1.38	1.75
		247	4.465	1.200	1.23	1.83
	50	248	4.615	1.200	1.68	5.47
		249	5.365	1.820	1.68	5.36
		250	5.670	2.400	1.68	5.22
		251	5.165	2.410	1.48	5.58
		252	5.205	1.200	1.85	5.22
	60	253	4.605	1.200	2.10	2.76
		254	5.310	1.805	2.10	2.70
		255	5.825	2.400	2.10	2.69
		256	5.520	1.200	2.35	2.75
		257	5.875	1.200	2.48	2.69
	70	258	4.645	1.200	2.48	1.37
		259	5.205	1.800	2.48	1.42
		260	5.435	2.390	2.48	1.28
		261	4.950	1.200	2.60	1.42
		262	5.400	1.200	2.80	1.37
	80	263	4.145	1.200	2.61	0.63
		264	4.630	1.820	2.61	0.61
		265	5.230	2.410	2.61	0.62
		266	4.360	1.200	2.72	0.62
		267	5.560	1.200	3.18	0.64
	90	268	5.250	2.380	2.82	0.247
	90	269	4.170	1.800	2.82	0.263
3	90	270	4.980	1.800	3.00	0.197
	100	271	5.360	2.440	2.93	0.081
	100	272	4.880	1.800	2.93	0.074
	100	273	5.460	2.030	3.16	0.088
4	30	274	5.200	1.200	1.00	22.09
	30	275	5.570	1.800	1.00	21.01
	30	277	3.970	1.400	0.80	22.48
	40	278	4.000	1.200	1.13	10.69
		279	4.470	1.800	1.13	10.54
		280	4.890	2.400	1.13	9.85
		281	5.000	1.240	1.36	10.06
		282	4.310	1.200	1.23	10.25
	50	283	4.635	1.200	1.68	5.27
		285	5.580	2.400	1.68	4.80
		286	5.070	2.400	1.48	5.09
		287	5.115	1.200	1.85	4.80
	60	288	4.480	1.200	2.10	2.51
		289	5.100	1.890	2.10	2.27
		290	5.550	2.400	2.10	2.41
		291	5.500	1.200	2.35	2.63
		292	5.790	[illegible]	2.48	2.44
	70	293	4.680	1.200	2.48	1.33
		294	5.090	1.800	2.48	1.25
		295	5.860	2.400	2.48	1.32
		296	5.140	1.200	2.60	1.30
		297	4.650	1.200	2.80	1.33
	80	298	4.325	1.190	2.61	0.60
		299	4.835	1.820	2.61	0.59
		300	5.520	2.400	2.61	0.60
		302	5.680	1.190	3.16	0.62
	90	303	5.630	2.400	2.82	0.236
	90	304	5.070	1.800	2.82	0.236
	90	305	5.390	1.800	3.00	0.212
	100	306	5.550	2.400	2.93	0.055
	100	307	5.160	1.800	2.93	0.063
	100	308	5.880	2.080	3.18	0.057
5	20	335	5.720	2.200	0.60	59.19
	20	336	5.460	1.820	0.60	60.00
	20	337	4.870	1.320	0.60	[illegible]9.72
	30	338	3.680	1.190	0.80	[illegible].88
		339	4.330	1.800	0.80	22.48
		340	4.890	2.470	0.80	2[illegible].29
		341	5.750	1.840	1.00	[illegible]2.22
	40	342	3.930	1.180	1.13	11.04
	40	343	4.470	1.820	1.13	10.69
	40	344	5.160	2.400	1.13	10.79
	40	345	5.090	1.220	1.38	10.53
	50	346	4.510	1.200	1.68	5.25
		347	5.140	1.850	1.68	5.27
		348	5.640	2.360	1.68	5.29

(Continued)

Table 1 (Concluded)

Type Culvert Expansion	Valve Opening Percent	Run No.	Headwater Elevation	Lock Chamber Elevation	Discharge CFS	Valve Loss Coefficient	Type Culvert Expansion	Valve Opening Percent	Run No.	Headwater Elevation	Lock Chamber Elevation	Discharge CFS	Valve Loss Coefficient	Type Culvert Expansion	Valve Opening Percent	Run No.	Headwater Elevation	Lock Chamber Elevation	Discharge CFS	Valve Loss Coefficient
5		349	3.860	1.210	1.48	5.35	6	65	400	5.630	1.885	2.60	1.48	7	90	406	5.180	1.970	2.90	0.248
		350	5.170	1.220	1.85	5.17		65	401	4.825	1.560	2.40	1.49		90	407	4.490	1.810	2.70	0.226
	60	351	4.370	1.190	2.10	2.54		65	402	4.030	1.260	2.20	1.51		90	408	5.510	2.300	3.00	0.218
		352	5.090	1.830	2.10	2.61		70	385	4.740	1.815	2.48	1.04		100	403	4.755	2.100	2.76	0.166
		353	5.620	2.440	2.10	2.59		70	386	5.460	1.725	2.80	1.02		100	404	5.245	2.310	2.93	0.170
		354	5.210	1.260	2.35	2.49		70	387	4.060	1.865	2.15	1.03		100	405	5.460	1.940	3.18	0.150
		355	5.470	1.170	2.48	2.48		80	388	4.385	1.690	2.61	0.483	8	30	433	3.330	1.110	0.75	22.8
	70	356	4.280	1.190	2.48	1.24		80	389	5.330	1.845	3.00	0.464		30	434	4.450	1.620	0.90	19.6
		357	4.930	1.775	2.48	1.27		80	390	4.965	1.880	2.80	0.460		30	435	5.220	1.680	1.10	16.7
		358	5.580	2.400	2.48	1.24		90	391	4.810	1.990	2.82	0.239		40	436	2.670	1.120	0.90	9.58
		359	4.710	1.220	2.60	1.26		90	392	5.410	2.240	3.00	0.218		40	437	3.790	1.090	1.20	9.66
		360	5.200	1.190	2.80	1.25		90	393	4.910	2.315	2.70	0.226		40	438	5.180	1.620	1.50	7.95
	80	361	3.930	1.200	2.61	0.539		100	394	5.190	2.290	2.93	0.133		50	439	3.290	1.300	1.40	4.12
		362	4.520	1.800	2.61	0.576		100	395	5.580	2.110	3.18	0.113			440	3.840	1.230	1.60	4.31
		363	5.130	2.440	2.61	--		100	396	4.580	2.030	2.76	0.141			441	5.140	1.760	1.84	4.19
		364	4.220	1.150	2.72	0.591	7	30	430	5.285	1.775	1.00	19.87			442	5.520	1.740	2.00	3.98
		365	5.350	1.230	3.18	0.576		30	431	4.550	1.750	0.90	19.61		55	443	3.350	1.020	1.70	2.87
	90	366	5.200	2.430	2.82	0.223		30	432	4.010	1.770	0.80	19.80			444	4.170	1.270	1.90	2.91
	90	367	4.620	1.790	2.82	0.215		40	427	5.010	1.710	1.38	8.67			445	5.070	1.610	2.10	2.81
	90	368	4.930	1.800	3.00	0.211		40	428	3.710	1.440	1.13	8.76			446	5.670	1.860	2.30	2.55
	100	369	5.270	2.400	2.93	0.118		40	429	2.690	1.195	0.89	9.36		60	447	3.380	1.160	1.80	2.04
	100	370	4.710	1.870	2.93	0.089		50	424	4.970	1.730	1.85	3.89			448	3.920	1.390	2.00	1.92
	100	371	5.250	1.860	3.18	0.106		50	425	4.460	1.810	1.68	3.86			449	5.210	1.520	2.40	1.96
6	30	372	3.610	1.140	0.80	21.98		50	426	3.535	1.290	1.48	4.16			450	5.860	1.770	2.54	1.99
		373	3.980	1.720	0.80	20.10		55	421	5.420	1.820	2.20	2.72			463	5.100	1.290	2.48	1.95
		374	5.240	1.830	1.00	19.37		55	422	4.780	1.765	2.00	2.67			462	3.980	1.130	2.10	1.99
		375	4.840	1.830	0.90	21.09		55	423	1.935	1.535	1.80	2.56			461	3.455	1.090	1.92	1.97
	40	376	4.230	1.690	1.13	10.10		60	418	5.545	1.675	2.48	1.96		65	451	3.18[illegible]	1.040	1.90	1.42
	40	377	5.340	1.800	1.38	9.47		60	419	4.630	1.750	2.10	1.98			452	4.250	1.180	2.20	1.53
	40	378	2.730	1.265	0.89	9.36		60	420	3.920	1.450	1.92	2.11			453	5.630	2.200	2.50	1.35
	50	379	4.725	1.790	1.68	4.51		65	415	5.520	1.760	2.60	1.44			454	5.890	2.120	2.68	1.29
	50	380	3.600	1.170	1.48	4.83		65	416	4.535	1.490	2.40	1.41		7[illegible]	455	3.020	0.960	2.00	0.72
	50	381	5.130	1.700	1.85	4.33		65	417	3.975	1.265	2.20	1.44		70	456	4.720	1.600	2.52	0.84
	55	397	5.580	1.810	2.20	2.96		70	412	5.430	1.700	2.80	1.01		70	457	5.870	2.080	2.80	1.06
	55	398	4.900	1.675	2.00	3.02		70	413	4.960	2.000	2.48	0.99		80	458	4.12[illegible]	1.710	2.40	0.44
	55	399	4.040	1.470	1.80	2.91		70	414	4.310	1.970	2.15	1.01		80	459	5.230	[illegible].040	2.80	0.37
	60	382	4.720	1.780	2.10	2.11		80	409	4.480	1.780	2.61	0.465		80	460	5.840	2.330	3.10	0.36
	60	383	5.380	1.410	2.48	2.13		80	410	5.280	2.200	2.80	0.493							
	60	384	3.860	1.320	1.92	2.25		80	411	5.360	1.820	3.00	0.507							

Table 2

Average Piezometer Readings, Type 1 Expansion

Piezometer Locations			Run Number*														
No.	Station	Elevation	332	333	334	198	201	202	197	199	194	196	195	155	156	175	176
4	15.00U	0.56	5.62	5.11	4.58	4.53	5.12	5.50	5.36	5.10	3.23	3.89	4.47	4.83	3.68	3.52	4.06
5	8.79U		5.61	5.10	4.57	4.49	5.08	5.47	5.31	5.06	3.16	3.83	4.42	4.74	3.62	3.40	3.96
6	6.75U		5.60	5.09	4.56	4.48	5.07	5.46	5.30	5.04	3.15	3.82	4.40	4.72	3.61	3.39	3.94
7	4.79U		5.60	5.09	4.56	4.48	5.06	5.45	5.29	5.03	3.14	3.81	4.40	4.70	3.59	3.36	3.91
8	2.79U		5.60	5.09	4.55	4.47	5.05	5.44	5.28	5.02	3.13	3.80	4.39	4.69	3.59	3.35	3.91
9	1.79U		5.59	5.08	4.55	4.46	5.03	5.43	5.27	5.00	3.12	3.79	4.38	4.66	3.57	3.31	3.85
14	0.08D		1.61	1.12	0.40	0.08	0.57	1.06	-0.32	-0.18	0.14	0.80	1.38	-0.68	0.00	-0.22	0.42
15	0.22D		1.60	1.11	0.39	--	--	--	--	--	--	--	--	--	--	--	--
16	0.36D		1.59	1.10	0.38	0.06	0.56	1.04	-0.34	-0.20	0.12	0.78	1.35	-0.70	-0.02	-0.30	0.42
17	0.50D		1.58	1.09	0.37	0.06	0.52	1.03	-0.36	-0.22	0.10	0.76	1.33	-0.74	-0.04	-0.32	0.40
18	0.64D		1.57	1.08	0.37	0.05	0.51	1.02	-0.36	-0.23	0.09	0.76	1.32	-0.76	-0.06	-0.30	0.44
19	0.78D		1.58	1.08	0.37	0.04	0.52	1.01	-0.36	-0.24	0.08	0.75	1.32	-0.79	-0.06	-0.26	0.44
20	0.92D		1.59	1.09	0.38	0.04	0.54	1.02	-0.36	-0.26	0.10	0.77	1.34	-0.78	-0.06	-0.24	0.46
21	1.06D		1.61	1.10	0.39	0.05	0.56	1.04	-0.34	-0.22	0.14	0.84	1.36	-0.74	-0.04	-0.22	0.50
22	1.20D		1.63	1.12	0.40	0.07	0.63	1.07	-0.30	-0.20	0.16	0.86	1.38	-0.68	0.04	-0.12	0.60
23	1.34D		1.65	1.13	0.43	0.09	0.65	1.10	-0.28	-0.12	0.20	0.88	1.42	-0.64	0.10	0.04	0.68
24	1.48D		1.68	1.16	0.46	0.16	0.68	1.16	-0.22	-0.10	0.28	0.94	1.44	-0.60	0.20	0.10	0.86
25	1.62D		1.71	1.19	0.50	0.25	0.73	1.21	-0.16	0.04	0.32	1.00	1.50	-0.46	0.24	0.30	0.92
26	1.76D		1.75	1.24	0.54	0.28	0.76	1.34	-0.08	0.10	0.36	1.10	1.60	-0.36	0.32	0.40	1.00
27	1.90D		1.78	1.30	0.58	0.34	0.84	1.40	-0.02	0.18	0.48	1.16	1.64	-0.24	0.40	0.50	1.10
28	2.04D		1.87	1.36	0.65	0.44	0.96	1.48	0.08	0.24	0.54	1.24	1.76	0.00	0.46	0.74	1.30
29	2.18D		1.93	1.42	0.74	0.50	1.06	1.66	0.22	0.46	0.64	1.44	1.82	0.12	0.60	0.92	1.40
30	2.46D		2.10	1.58	0.92	0.80	1.24	1.80	0.49	0.70	0.84	1.56	2.04	0.44	0.74	1.00	1.60
31	2.74D		2.20	1.74	1.07	0.88	1.46	1.96	0.76	0.88	1.00	1.68	2.24	0.76	0.96	1.12	1.88
32	3.02D		2.30	1.82	1.15	1.06	1.66	2.16	0.96	1.10	1.08	1.72	2.40	0.96	1.06	1.26	1.92
33	3.30D		2.34	1.86	1.18	1.16	1.76	2.24	1.08	1.20	1.16	1.80	2.46	1.04	1.16	1.30	1.94
34	3.58D		2.37	1.88	1.19	1.30	1.80	2.28	1.20	1.27	1.20	1.88	2.47	1.20	1.24	1.32	1.96
35	3.86D		2.38	1.89	1.20	1.30	1.82	2.29	1.24	1.29	1.22	1.90	2.48	1.24	1.27	1.34	1.98
36	4.80D		2.38	1.89	1.20	1.31	1.83	2.30	1.27	1.30	1.22	1.90	2.48	1.28	1.29	1.34	1.98
37	6.40D		2.38	1.89	1.20	1.32	1.84	2.31	1.28	1.30	1.24	1.91	2.49	1.28	1.29	1.34	1.98
39	9.60D		2.38	1.89	1.20	1.30	1.82	2.28	1.24	1.27	1.20	1.88	2.45	1.23	1.26	1.28	1.91
40	11.15D		2.37	1.88	1.19	1.28	1.81	2.27	1.24	1.26	1.20	1.86	2.44	1.22	1.25	1.26	1.88
41	12.70D		2.37	1.88	1.19	1.29	1.80	2.27	1.23	1.24	1.18	1.82	2.44	1.21	1.24	1.24	1.88

(Continued)

* Refer to Table 1 for flow conditions for each run.

(Sheet 1 of 3)

Table 2 (Continued)

Piezometer Locations No.	Station	Elevation	Run Number 177	157	184	167	168	169	174	179	163	159	172	171	178	170
4	15.00U	0.56	4.70	3.18	3.47	3.18	3.76	4.32	3.49	3.64	3.74	3.78	3.82	3.48	3.36	2.93
5	8.79U		4.60	3.10	3.35	3.02	3.61	4.17	3.34	3.48	3.56	3.60	3.63	3.26	3.14	2.73
6	6.75U		4.58	3.08	3.34	2.98	3.59	4.14	3.30	3.44	3.52	3.56	3.58	3.22	3.10	2.68
7	4.79U		4.55	3.06	3.32	2.96	3.56	4.12	3.28	3.42	3.48	3.53	3.55	3.16	3.07	2.60
8	2.79U		4.54	3.06	3.30	2.95	3.54	4.10	3.27	3.40	3.46	3.50	3.53	3.16	3.04	2.62
9	1.79U		4.51	3.02	3.28	2.90	3.49	4.04	3.21	3.35	3.40	3.43	3.44	3.09	2.98	2.52
14	0.08D		1.10	0.14	-0.24	-0.40	0.40	1.00	-0.06	-0.06	-0.55	-0.68	0.74	0.36	0.15	-0.20
15	0.22D		--	--	--	--	--	--	--	--	--	--	--	--	--	--
16	0.36D		1.08	0.12	-0.28	-0.44	0.36	0.96	-0.08	-0.08	-0.56	-0.72	0.76	0.40	0.18	-0.24
17	0.50D		1.04	0.11	-0.29	-0.48	0.38	0.92	-0.10	-0.10	-0.57	-0.76	0.80	0.46	0.20	-0.20
18	0.64D		1.08	0.10	-0.27	-0.36	0.46	0.96	-0.06	-0.04	-0.55	-0.76	0.86	0.50	0.26	-0.12
19	0.78D		1.12	0.11	-0.24	-0.36	0.46	1.08	0.00	0.00	-0.48	-0.72	1.06	0.60	0.42	0.04
20	0.92D		1.14	0.12	-0.21	-0.28	0.52	1.12	0.06	0.08	-0.40	-0.80	1.28	0.76	0.66	0.28
21	1.06D		1.16	0.20	-0.19	-0.20	0.56	1.24	0.16	0.16	-0.26	-0.44	1.36	1.04	0.80	0.56
22	1.20D		1.28	0.30	-0.12	0.08	0.84	1.40	0.32	0.36	-0.04	-0.20	1.56	1.32	1.06	0.68
23	1.34D		1.32	0.40	-0.02	0.20	1.06	1.50	0.72	0.56	0.16	0.02	1.72	1.40	1.16	0.84
24	1.48D		1.48	0.52	0.10	0.28	1.20	1.64	0.88	0.80	0.38	0.24	1.88	1.60	1.32	0.92
25	1.62D		1.52	0.60	0.28	0.72	1.32	1.66	0.96	1.04	0.58	0.42	1.94	1.64	1.48	1.08
26	1.76D		1.64	0.72	0.40	0.80	1.48	2.00	1.08	1.08	0.76	0.60	2.08	1.72	1.60	1.20
27	1.90D		1.96	0.82	0.51	0.84	1.60	2.10	1.14	1.20	0.92	0.74	2.14	1.84	1.66	1.26
28	2.04D		2.08	0.84	0.64	0.88	1.68	2.20	1.20	1.38	1.07	0.84	2.20	1.88	1.68	1.30
29	2.18D		2.14	1.04	0.82	1.08	1.72	2.30	1.36	1.40	1.18	1.04	2.26	1.94	1.72	1.32
30	2.46D		2.32	1.10	1.00	1.16	1.88	2.48	1.44	1.60	1.30	1.24	2.28	1.96	1.74	1.42
31	2.74D		2.40	1.28	1.12	1.24	1.92	2.52	1.50	1.64	1.36	1.37	2.30	2.00	1.76	1.46
32	3.02D		2.52	1.34	1.25	1.28	2.00	2.56	1.58	1.70	1.44	1.45	2.36	2.04	1.80	1.48
33	3.30D		2.56	1.38	1.32	1.36	2.06	2.60	1.64	1.72	1.50	1.48	2.38	2.06	1.82	1.48
34	3.58D		2.62	1.42	1.34	1.38	2.08	2.61	1.68	1.74	1.53	1.53	2.40	2.08	1.86	1.50
35	3.86D		2.65	1.42	1.36	1.37	2.08	2.62	1.70	1.76	1.55	1.56	2.42	2.08	1.88	1.50
36	4.80D		2.64	1.43	1.36	1.36	2.06	2.62	1.69	1.78	1.57	1.54	2.42	2.06	1.88	1.48
37	6.40D		2.58	1.43	1.35	1.37	2.06	2.61	1.68	1.75	1.56	1.52	2.40	2.06	1.86	1.48
39	9.60D		2.58	1.38	1.27	1.25	1.95	2.51	1.56	1.65	1.44	1.38	2.26	1.91	1.73	1.33
40	11.15D		2.56	1.37	1.26	1.24	1.93	2.50	1.55	1.62	1.42	1.36	2.23	1.38	1.69	1.28
41	12.70D		2.56	1.36	1.25	1.21	1.92	2.47	1.49	1.60	1.40	1.33	2.21	1.86	1.66	1.26

(Continued)

Table 2 (Concluded)

Piezometer Locations			Run Number													
No.	Station	Elevation	161	160	320	321	322	323	324	325	326	327	328	329	330	331
4	15.00U	0.56	3.23	2.76	2.48	3.00	3.61	2.58	2.78	3.35	2.91	2.26	3.00	3.33	2.73	2.92
5	8.79U		2.99	2.54	2.26	2.79	3.38	2.29	2.52	3.10	2.67	2.00	2.74	3.10	2.48	2.63
6	6.75U		2.94	2.56	2.21	2.73	3.33	2.24	2.40	3.00	2.59	1.90	2.63	3.01	2.39	2.53
7	4.79U		2.90	2.51	2.15	2.69	3.29	2.20	2.38	2.98	2.55	1.88	2.62	3.00	2.38	2.52
8	2.79U		2.86	2.48	2.13	2.66	3.26	2.18	2.36	2.96	2.53	1.86	2.60	2.98	2.36	2.49
9	1.79U		2.78	2.42	2.04	2.60	3.17	2.08	2.24	2.84	2.43	1.74	2.46	2.87	2.26	2.37
14	0.08D		-0.42	-0.08	0.42	1.03	1.66	0.38	0.18	2.00	1.51	0.84	1.45	2.75	2.13	2.23
15	0.22D		--	--	0.39	1.02	1.65	0.37	0.16	2.28	1.74	1.12	1.73	2.76	2.14	2.25
16	0.36D		-0.46	-0.06	0.43	1.06	1.70	0.42	0.30	2.47	2.00	1.33	1.95	2.77	2.14	2.25
17	0.50D		-0.50	-0.04	0.66	1.23	1.85	0.60	0.48	2.59	2.12	1.45	2.11	2.78	2.15	2.26
18	0.64D		-0.24	0.04	0.83	1.40	2.06	0.83	0.73	2.61	2.18	1.51	2.17	2.79	2.15	2.26
19	0.78D		-0.12	0.12	1.03	1.59	2.27	1.02	0.99	2.63	2.20	1.53	2.20	2.80	2.16	2.27
20	0.92D		0.08	0.28	1.15	1.76	2.44	1.22	1.20	2.65	2.21	1.54	2.21	2.80	2.16	2.27
21	1.06D		0.28	0.32	1.28	1.91	2.55	1.32	1.38	2.65	2.21	1.54	2.21	2.79	2.15	2.26
22	1.20D		0.52	0.72	1.40	1.99	2.58	1.39	1.45	2.65	2.21	1.54	2.21	2.79	2.15	2.26
23	1.34D		0.68	0.92	1.44	2.02	2.61	1.43	1.51	2.65	2.20	1.53	2.21	2.78	2.14	2.25
24	1.48D		0.92	1.12	1.48	2.05	2.65	1.47	1.54	2.66	2.20	1.53	2.21	2.78	2.14	2.25
25	1.62D		1.04	1.08	1.51	2.07	2.67	1.48	1.55	2.65	2.20	1.52	2.21	2.77	2.13	2.24
26	1.76D		1.16	1.16	1.52	2.08	2.68	1.49	1.56	2.65	2.19	1.51	2.21	2.77	2.13	2.23
27	1.90D		1.26	1.24	1.53	2.09	2.69	1.50	1.58	2.65	2.19	1.51	2.21	2.77	2.13	2.23
28	2.04D		1.32	1.28	1.54	2.10	2.69	1.51	1.58	2.65	2.18	1.51	2.21	2.76	2.13	2.22
29	2.18D		1.42	1.32	1.55	2.11	2.70	1.52	1.59	2.65	2.17	1.50	2.20	2.75	2.12	2.21
30	2.46D		1.50	1.40	1.56	2.12	2.71	1.53	1.59	2.64	2.17	1.50	2.20	2.75	2.12	2.21
31	2.74D		1.53	1.44	1.57	2.12	2.71	1.53	1.60	2.64	2.17	1.50	2.21	2.75	2.13	2.21
32	3.02D		1.57	1.46	1.56	2.12	2.70	1.53	1.59	2.62	2.15	1.47	2.17	2.72	2.10	2.18
33	3.30D		1.53	1.46	1.55	2.10	2.70	1.52	1.58	2.57	2.13	1.45	2.13	2.69	2.08	2.16
34	3.58D		1.54	1.48	1.54	2.10	2.70	1.51	1.59	2.57	2.14	1.47	2.15	2.70	2.09	2.17
35	3.86D		1.58	1.47	1.54	2.09	2.70	1.52	1.60	2.58	2.14	1.48	2.16	2.70	2.09	2.17
36	4.80D		1.56	1.47	1.50	2.07	2.69	1.50	1.57	2.55	2.12	1.46	2.13	2.67	2.06	2.15
37	6.40D		1.54	1.46	1.48	2.04	2.67	1.48	1.54	2.52	2.09	1.42	2.09	2.63	2.02	2.10
39	9.60D		1.40	1.33	1.40	1.96	2.59	1.40	1.43	2.44	2.00	1.32	1.99	2.55	1.93	1.99
40	11.15D		1.36	1.30	1.29	1.86	2.49	1.27	1.27	2.30	1.85	1.17	1.83	2.45	1.80	1.85
41	12.70D		1.34	1.28	1.32	1.89	2.52	1.31	1.33	2.36	1.91	1.23	1.90	2.49	1.85	1.90

(Sheet 3 of 3)

Table 3

Average Piezometer Readings, Type 2 Expansion

Piezometer Locations			Run Number*													
No.	Station	Elevation	208	209	210	211	212	213	214	215	216	217	218	219	220	221
4	15.00U	0.56	3.58	4.05	4.66	4.48	4.75	5.21	5.36	3.51	4.17	4.74	4.52	4.85	4.44	3.67
5	8.79U		3.54	4.03	4.63	4.44	4.71	5.17	5.31	3.46	4.10	4.68	4.44	4.75	4.32	3.56
6	6.75U		3.54	4.02	4.62	4.44	4.70	5.16	5.30	3.45	4.09	4.66	4.42	4.74	4.30	3.54
7	4.79U		3.54	4.02	4.62	4.43	4.70	5.15	5.30	3.44	4.08	4.66	4.41	4.72	4.28	3.52
8	2.79U		3.54	3.96	4.56	4.44	4.69	5.14	5.29	3.42	4.08	4.65	4.40	4.70	4.27	3.50
9	1.79U		3.52	4.00	4.60	4.40	4.67	5.12	5.28	3.40	4.07	4.62	4.38	4.66	4.24	3.46
14	0.08D	0.57	0.62	1.28	1.89	0.62	0.36	0.36	1.18	0.38	1.09	1.74	0.00	1.40	0.70	-0.16
15	0.22D	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
16	0.36D	0.60	0.61	1.26	1.88	0.55	0.35	0.35	1.18	0.40	1.09	1.73	-0.01	1.38	0.69	-0.20
17	0.50D	0.61	0.61	1.26	1.88	0.54	0.36	0.34	1.18	0.40	1.08	1.73	-0.03	1.36	0.68	-0.20
18	0.64D	0.62	0.61	1.26	1.88	0.50	0.36	0.34	1.18	0.38	1.07	1.72	0.00	1.37	0.67	-0.18
19	0.78D	0.64	0.61	1.25	1.88	0.51	0.36	0.34	1.18	0.38	1.06	1.71	0.00	1.38	0.66	-0.16
20	0.92D	0.65	0.60	1.26	1.88	0.44	0.36	0.34	1.18	0.39	1.08	1.70	0.02	1.42	0.69	-0.14
21	1.06D	0.67	0.60	1.26	1.88	0.47	0.36	0.36	1.18	0.39	1.09	1.71	0.02	1.44	0.74	-0.10
22	1.20D	0.68	0.60	1.26	1.88	0.46	0.36	0.36	1.18	0.40	1.09	1.74	0.03	1.48	0.75	-0.08
23	1.34D	0.69	0.61	1.27	1.89	0.46	0.36	0.38	1.18	0.44	1.10	1.76	0.06	1.52	0.80	-0.04
24	1.48D	0.71	0.61	1.28	1.89	0.46	0.38	0.38	1.20	0.44	1.11	1.79	0.08	1.56	0.82	0.04
25	1.62D	0.72	0.63	1.28	1.90	0.49	0.39	0.38	1.20	0.46	1.12	1.79	0.08	1.62	0.88	0.06
26	1.76D	0.74	0.64	1.29	1.91	0.50	0.42	0.44	1.22	0.47	1.12	1.80	0.12	1.66	0.96	0.10
27	1.90D	0.75	0.64	1.30	1.92	0.52	0.42	0.45	1.22	0.56	1.16	1.82	0.16	1.70	1.00	0.18
28	2.04D	0.76	0.65	1.31	1.94	0.54	0.44	0.46	1.26	0.58	1.18	1.86	0.18	1.74	1.04	0.22
29	2.18D	0.78	0.65	1.32	1.95	0.56	0.45	0.46	1.28	0.58	1.21	1.88	0.21	1.82	1.08	0.30
30	2.46D	0.81	0.66	1.33	1.98	0.60	0.52	0.50	1.28	0.60	1.23	1.90	0.28	1.94	1.24	0.38
31	2.74D	0.83	0.70	1.36	2.00	0.64	0.54	0.60	1.34	0.64	1.28	1.98	0.34	2.00	1.30	0.46
32	3.02D	0.86	0.74	1.40	2.04	0.66	0.60	0.70	1.37	0.70	1.36	2.01	0.40	2.14	1.40	0.58
33	3.30D	0.88	0.80	1.41	2.06	0.74	0.62	0.72	1.50	0.74	1.44	2.06	0.42	2.20	1.41	0.70
34	3.58D		0.84	1.48	2.12	0.76	0.78	0.78	1.51	0.80	1.52	2.12	0.60	2.26	1.60	0.82
35	3.86D		0.92	1.52	2.16	0.88	0.88	0.92	1.56	1.00	1.60	2.26	0.72	2.36	1.64	0.98
36	4.80D		1.10	1.76	2.30	1.04	1.04	1.20	1.62	1.21	1.80	2.40	1.12	2.58	1.70	1.16
37	6.40D		1.19	1.82	2.40	1.34	1.23	1.32	1.92	1.21	1.87	2.52	1.21	2.60	2.00	1.20
39	9.60D		1.18	1.81	2.43	1.28	1.22	1.31	2.00	1.22	1.86	2.51	1.19	2.58	1.99	1.17
40	11.15D		1.18	1.80	2.42	1.26	1.22	1.30	2.00	1.21	1.86	2.50	1.19	2.56	1.98	1.16
41	12.70D		1.18	1.81	2.41	1.22	1.22	1.31	2.00	1.21	1.86	2.50	1.18	2.54	1.98	1.16

(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 3 (Concluded)

Piezometer Locations			Run Number												
No.	Station	Elevation	223	224	226	227	228	229	230	231	232	233	234	235	236
4	15.00U	0.56	4.43	3.80	3.30	3.88	3.31	2.76	3.14	2.56	1.93	2.73	2.12	2.51	1.91
5	8.79U		4.27	3.63	3.11	3.64	3.06	2.50	2.88	2.28	1.66	2.43	1.81	2.20	1.58
6	6.75U		4.24	3.60	3.09	3.58	3.02	2.46	2.83	2.23	1.62	2.35	1.75	2.13	1.53
7	4.79U		4.20	3.57	3.06	3.54	2.98	2.42	2.79	2.17	1.57	2.31	1.70	2.07	1.47
8	2.79U		4.18	3.55	3.05	3.48	2.95	2.40	2.75	2.12	1.54	2.27	1.66	2.04	1.43
9	1.79U		4.13	3.48	2.99	3.43	2.87	2.30	2.66	2.03	1.52	2.06	1.55	1.92	1.30
14	0.08D	0.57	0.94	0.36	-0.34	0.80	0.19	-0.46	1.11	0.38	-0.11	1.21	0.58	1.78	1.15
15	0.22D	--	--	--	--	--	--	--	--	--	--	--	0.75	1.86	1.25
16	0.36D	0.60	0.90	0.35	-0.35	0.76	0.18	-0.50	1.15	0.42	-0.06	1.35	0.92	1.94	1.33
17	0.50D	0.61	0.88	0.34	-0.36	0.75	0.17	-0.48	1.24	0.48	-0.04	1.40	1.06	1.99	1.39
18	0.64D	0.62	0.89	0.32	-0.38	0.78	0.20	-0.46	1.30	0.54	0.04	1.66	1.16	2.04	1.44
19	0.78D	0.64	0.92	0.33	-0.34	0.88	0.26	-0.32	1.42	0.70	0.16	1.76	1.25	2.08	1.46
20	0.92D	0.65	0.98	0.40	-0.28	0.94	0.36	-0.28	1.54	0.82	0.28	1.87	1.34	2.11	1.51
21	1.06D	0.67	1.00	0.46	-0.20	1.08	0.43	-0.20	1.64	0.94	0.38	1.94	1.40	2.15	1.55
22	1.20D	0.68	1.06	0.52	-0.16	1.16	0.58	-0.04	1.76	1.03	0.48	1.99	1.48	2.19	1.58
23	1.34D	0.69	1.14	0.60	-0.06	1.26	0.64	0.00	1.84	1.14	0.58	2.06	1.52	2.21	1.62
24	1.48D	0.71	1.30	0.66	0.00	1.36	0.84	0.14	1.92	1.22	0.66	2.09	1.55	2.23	1.63
25	1.62D	0.72	1.36	0.70	0.10	1.46	0.92	0.20	2.00	1.30	0.72	2.13	1.58	2.25	1.67
26	1.76D	0.74	1.50	0.86	0.12	1.52	0.96	0.28	2.10	1.36	0.78	2.16	1.61	2.28	1.69
27	1.90D	0.75	1.52	0.92	0.26	1.62	1.04	0.48	2.12	1.42	0.86	2.20	1.64	2.31	1.71
28	2.04D	0.76	1.56	0.98	0.30	1.70	1.20	0.52	2.16	1.50	0.90	2.25	1.67	2.33	1.74
29	2.18D	0.78	1.68	1.08	0.32	1.80	1.25	0.56	2.18	1.54	0.94	2.27	1.70	2.36	1.76
30	2.46D	0.81	1.80	1.34	0.44	1.86	1.40	0.68	2.24	1.60	1.02	2.30	1.74	2.40	1.80
31	2.74D	0.83	1.86	1.36	0.62	2.00	1.44	0.76	2.30	1.66	1.08	2.33	1.78	2.45	1.85
32	3.02D	0.86	2.00	1.40	0.68	2.04	1.50	0.84	2.38	1.72	1.12	2.37	1.83	2.50	1.88
33	3.30D	0.88	2.06	1.48	0.80	2.12	1.56	0.96	2.42	1.78	1.18	2.43	1.87	2.53	1.92
34	3.58D		2.12	1.56	0.86	2.20	1.64	1.00	2.44	1.80	1.22	2.48	1.89	2.52	1.92
35	3.86D		2.30	1.72	1.04	2.30	1.72	1.08	2.48	1.83	1.24	2.48	1.89	2.52	1.92
36	4.80D		2.46	1.88	1.22	2.44	1.88	1.28	2.50	1.88	1.30	2.49	1.90	2.52	1.92
37	6.40D		2.47	1.90	1.28	2.50	1.92	1.34	2.54	1.87	1.31	2.51	1.91	2.53	1.92
39	9.60D		2.46	1.88	1.26	2.46	1.90	1.28	2.52	1.87	1.28	2.47	1.87	2.49	1.89
40	11.15D		2.44	1.86	1.25	2.45	1.89	1.26	2.50	1.85	1.25	2.45	1.85	2.47	1.87
41	12.70D		2.44	1.86	1.24	2.43	1.88	1.24	2.48	1.83	1.24	2.43	1.83	2.45	1.85

Table 4

Average Piezometer Readings, Type 3 Expansion

Piezometer Locations			Run Number*											
No.	Station	Elevation	240	241	242	243	244	245	246	247	248	249	250	251
4	15.00U	0.56	4.73	5.37	3.69	3.48	4.12	4.65	4.55	3.92	3.67	4.42	4.79	4.41
5	8.79U		4.68	5.31	3.66	3.42	4.06	4.58	4.44	3.84	3.53	4.28	4.65	4.30
6	6.75U		4.67	5.30	3.65	3.41	4.04	4.57	4.42	3.82	3.50	4.26	4.62	4.28
7	4.79U		4.66	5.29	3.65	3.40	4.03	4.56	4.41	3.81	3.48	4.24	4.61	4.26
8	2.79U		4.64	5.28	3.64	3.39	4.03	4.55	4.40	3.80	3.47	4.22	4.59	4.26
9	1.79U		4.64	5.26	3.63	3.37	4.01	4.53	4.38	3.77	3.44	4.19	4.55	4.23
14	0.07D		0.38	0.82	0.84	0.39	1.08	1.59	-0.02	0.13	-0.15	0.56	1.20	1.43
15	0.18D		0.38	0.82	0.84	0.37	1.07	1.58	-0.02	0.12	-0.16	0.55	1.20	1.42
16	0.33D		0.37	0.82	0.84	0.36	1.07	1.58	-0.02	0.12	-0.16	0.55	1.19	1.41
17	0.47D	0.58	0.36	0.82	0.84	0.36	1.07	1.57	-0.03	0.12	-0.16	0.55	1.18	1.41
18	0.61D	0.59	0.36	--	--	0.36	1.06	1.57	-0.03	0.11	-0.16	0.55	1.17	1.40
19	0.75D	0.61	0.36	0.81	0.82	0.36	1.05	1.57	-0.03	0.11	-0.16	0.57	1.19	1.41
20	0.89D	0.62	0.36	0.82	0.83	0.37	1.06	1.56	-0.02	0.11	-0.13	0.60	1.22	1.43
21	1.03D	0.63	0.38	0.82	0.83	0.39	1.07	1.58	0.00	0.12	-0.10	0.64	1.24	1.46
22	1.17D	0.65	0.38	0.83	0.84	0.39	1.09	1.60	0.02	0.14	-0.07	0.67	1.27	1.49
23	1.31D	0.66	0.40	0.84	0.85	0.41	1.10	1.62	0.05	0.17	0.00	0.70	1.32	1.55
24	1.45D	0.68	0.41	0.85	0.85	0.45	1.12	1.64	0.07	0.18	0.05	0.76	1.37	1.61
25	1.59D	0.69	0.42	0.87	0.86	0.47	1.15	1.66	0.11	0.20	0.10	0.01	1.43	1.65
26	1.73D	0.70	0.44	0.88	0.88	0.50	1.18	1.68	0.15	0.25	0.17	0.90	1.49	1.71
27	1.87D	0.72	0.46	0.90	0.90	0.52	1.22	1.70	0.20	0.30	0.23	0.95	1.56	1.77
28	2.01D	0.73	0.50	0.94	0.91	0.55	1.24	1.73	0.25	0.33	0.29	1.01	1.62	1.81
29	2.15D	0.75	0.52	0.97	0.93	0.60	1.28	1.78	0.30	0.37	0.38	1.09	1.67	1.86
30	2.29D	0.76	0.57	1.00	0.96	0.62	1.32	1.81	0.33	0.40	0.44	1.15	1.73	1.91
31	2.43D	0.77	0.61	1.02	0.97	0.65	1.35	1.83	0.37	0.44	0.51	1.21	1.79	1.94
32	2.71D	0.80	0.66	1.04	1.01	0.69	1.40	1.85	0.44	0.52	0.57	1.30	1.85	2.03
33	2.99D	0.83	0.70	1.12	1.04	0.76	1.45	1.90	0.53	0.58	0.68	1.39	1.95	2.09
34	3.27D	0.86	0.74	1.20	1.06	0.85	1.52	1.94	0.61	0.65	0.78	1.48	2.04	2.13
35	3.55D	0.88	0.79	1.28	1.10	0.90	1.60	2.00	0.75	0.80	0.88	1.57	2.15	2.20
36	3.83D		0.90	1.32	1.19	1.00	1.63	2.11	0.82	0.85	1.00	1.65	2.22	2.26
37	4.11D		0.96	1.40	1.24	1.05	1.70	2.20	0.94	0.91	1.09	1.75	2.35	2.35
38	5.05D		1.22	1.67	1.40	1.20	1.89	2.40	1.15	1.10	1.20	1.87	2.45	2.46
39	6.65D		1.22	1.72	1.41	1.25	1.91	2.42	1.24	1.16	1.23	1.95	2.50	2.49
40	8.04D		1.22	1.72	1.41	1.24	1.90	2.41	1.23	1.16	1.22	1.94	2.48	2.48
41	9.60D		1.22	1.72	1.40	1.23	1.90	2.41	1.23	1.16	1.22	1.93	2.46	2.48
42	11.15D		1.22	1.72	1.40	1.23	1.90	2.41	1.23	1.16	1.22	1.92	2.46	2.47
43	12.70D		1.22	1.72	1.40	1.22	1.90	2.40	1.22	1.15	1.21	1.91	2.45	2.47

(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 4 (Continued)

Piezometer Locations			Run Number										
No.	Station	Elevation	252	253	254	255	256	257	258	259	260	261	262
4	15.00U	0.56	4.10	3.18	3.92	4.46	3.76	3.92	2.55	3.20	3.61	2.69	2.86
5	8.79U		3.95	2.97	3.72	4.26	3.50	3.68	2.34	2.97	3.41	2.46	2.60
6	6.75U		3.92	2.93	3.68	4.22	3.46	3.63	2.30	2.92	3.36	2.41	2.51
7	4.79U		3.90	2.90	3.66	4.20	3.42	3.59	2.26	2.87	3.32	2.37	2.50
8	2.79U		3.88	2.88	3.64	4.18	3.39	3.56	2.23	2.85	3.30	2.34	2.45
9	1.79U		3.83	2.84	3.57	4.12	3.30	3.48	2.14	2.75	3.21	2.25	2.33
14	0.07D		-0.27	-0.36	0.47	1.06	-0.63	-0.83	-0.46	0.12	0.86	-0.67	-0.94
15	0.18D		-0.27	-0.37	0.46	1.05	-0.64	-0.84	-0.46	0.13	0.87	-0.68	-0.94
16	0.33D		-0.28	-0.38	0.45	1.05	-0.65	-0.85	-0.45	0.15	0.88	-0.67	-0.93
17	0.47D	0.58	-0.29	-0.39	0.45	1.05	-0.65	-0.85	-0.43	0.18	0.90	-0.66	-0.92
18	0.61D	0.59	-0.30	-0.40	0.45	1.06	-0.65	-0.85	-0.40	0.23	0.93	-0.62	-0.86
19	0.75D	0.61	-0.29	-0.36	0.47	1.10	-0.61	-0.78	-0.35	0.30	0.98	-0.51	-0.75
20	0.89D	0.62	-0.27	-0.32	0.51	1.15	-0.57	-0.70	-0.30	0.40	1.09	-0.43	-0.64
21	1.03D	0.63	-0.22	-0.22	0.60	1.20	-0.49	-0.64	-0.17	0.51	1.20	-0.31	-0.49
22	1.17D	0.65	-0.15	-0.15	0.67	1.27	-0.40	-0.55	-0.07	0.62	1.30	-0.20	-0.37
23	1.31D	0.66	-0.08	-0.06	0.76	1.34	-0.29	-0.44	0.06	0.76	1.40	-0.10	-0.24
24	1.45D	0.68	-0.03	0.03	0.84	1.41	-0.15	-0.28	0.17	0.88	1.51	0.05	-0.12
25	1.59D	0.69	0.05	0.10	0.91	1.48	-0.03	-0.16	0.27	0.98	1.58	0.18	0.02
26	1.73D	0.70	0.11	0.20	0.99	1.55	0.06	-0.04	0.38	1.09	1.65	0.30	0.13
27	1.87D	0.72	0.19	0.29	1.06	1.65	0.14	0.05	0.49	1.19	1.71	0.40	0.24
28	2.01D	0.73	0.26	0.38	1.17	1.73	0.23	0.14	0.57	1.26	1.77	0.49	0.35
29	2.15D	0.75	0.31	0.47	1.28	1.82	0.34	0.24	0.63	1.32	1.83	0.55	0.44
30	2.29D	0.76	0.37	0.54	1.36	1.92	0.42	0.34	0.73	1.37	1.90	0.62	0.52
31	2.43D	0.77	0.43	0.65	1.45	2.02	0.50	0.43	0.78	1.44	1.96	0.71	0.61
32	2.71D	0.80	0.51	0.78	1.55	2.15	0.61	0.55	0.84	1.52	2.06	0.79	0.69
33	2.99D	0.83	0.59	0.87	1.64	2.26	0.78	0.70	0.93	1.62	2.15	0.86	0.81
34	3.27D	0.86	0.68	0.93	1.71	2.32	0.91	0.85	1.07	1.70	2.24	0.96	0.92
35	3.55D	0.88	0.78	1.02	1.80	2.46	1.08	0.98	1.14	1.80	2.29	1.03	1.04
36	3.83D		0.90	1.16	1.90	2.52	1.21	1.10	1.20	1.87	2.34	1.10	1.15
37	4.11D		1.03	1.23	1.97	2.56	1.28	1.20	1.25	1.90	2.37	1.20	1.21
38	5.05D		1.25	1.26	2.05	2.62	1.37	1.36	1.32	1.92	2.46	1.28	1.31
39	6.65D		1.32	1.28	2.08	2.62	1.38	1.39	1.32	1.93	2.47	1.30	1.32
40	8.04D		1.31	1.26	2.06	2.61	1.37	1.37	1.32	1.92	2.46	1.28	1.30
41	9.60D		1.30	1.24	2.05	2.60	1.36	1.36	1.30	1.90	2.44	1.27	1.28
42	11.15D		1.30	1.24	2.05	2.60	1.35	1.35	1.28	1.88	2.43	1.25	1.27
43	12.70D		1.28	1.23	2.03	2.58	1.33	1.33	1.27	1.87	2.42	1.24	1.25

(Continued)

Table 4 (Concluded)

Piezometer Locations			Run Number										
No.	Station	Elevation	263	264	265	266	267	268	269	270	271	272	273
4	15.00U	0.56	1.86	2.45	3.02	1.90	2.19	2.64	2.04	1.91	2.51	1.90	2.13
5	8.79U		1.63	2.24	2.81	1.66	1.86	2.36	1.81	1.60	2.22	1.57	1.76
6	6.75U		1.58	2.18	2.76	1.61	1.78	2.31	1.77	1.53	2.15	1.51	1.69
7	4.79U		1.54	2.13	2.72	1.57	1.71	2.26	1.73	1.47	2.11	1.45	1.63
8	2.79U		1.51	2.11	2.69	1.53	1.67	2.22	1.71	1.43	2.08	1.42	1.59
9	1.79U		1.41	2.02	2.60	1.44	1.53	2.11	1.62	1.31	1.95	1.30	1.45
14	0.07D		-0.25	0.45	1.01	-0.35	-0.95	1.02	0.75	0.09	1.78	1.09	1.25
15	0.18D		-0.25	0.45	1.00	-0.34	-0.95	1.25	0.94	0.37	1.75	1.07	1.23
16	0.33D		-0.18	0.53	1.08	-0.28	-0.86	1.51	1.12	0.65	1.83	1.15	1.31
17	0.47D	0.58	-0.09	0.61	1.15	-0.18	-0.77	1.66	1.23	0.86	1.91	1.24	1.40
18	0.61D	0.59	-0.02	0.70	1.25	-0.08	-0.61	1.76	1.33	0.96	1.94	1.27	1.44
19	0.75D	0.61	0.10	0.80	1.37	0.06	-0.45	1.85	1.40	1.05	2.03	1.38	1.54
20	0.89D	0.62	0.23	0.93	1.48	0.18	-0.30	1.92	1.45	1.14	2.07	1.41	1.58
21	1.03D	0.63	0.37	1.02	1.60	0.31	-0.12	1.97	1.50	1.20	2.11	1.45	1.62
22	1.17D	0.65	0.45	1.13	1.70	0.43	0.04	2.02	1.55	1.25	2.15	1.49	1.67
23	1.31D	0.66	0.56	1.22	1.78	0.53	0.19	2.05	1.58	1.30	2.18	1.52	1.71
24	1.45D	0.68	0.65	1.31	1.84	0.62	0.36	2.09	1.61	1.35	2.22	1.56	1.75
25	1.59D	0.69	0.71	1.39	1.89	0.68	0.46	2.13	1.64	1.39	2.25	1.59	1.79
26	1.73D	0.70	0.77	1.44	1.96	0.76	0.58	2.16	1.66	1.43	2.28	1.62	1.82
27	1.87D	0.72	0.84	1.48	2.03	0.83	0.66	2.19	1.68	1.46	2.31	1.65	1.85
28	2.01D	0.73	0.90	1.52	2.08	0.88	0.74	2.22	1.70	1.49	2.33	1.68	1.88
29	2.15D	0.75	0.95	1.58	2.13	0.92	0.80	2.24	1.72	1.52	2.35	1.70	1.91
30	2.29D	0.76	1.00	1.62	2.17	0.96	0.86	2.28	1.74	1.55	2.37	1.73	1.94
31	2.43D	0.77	1.03	1.68	2.20	1.00	0.94	2.30	1.76	1.57	2.39	1.75	1.97
32	2.71D	0.80	1.10	1.73	2.25	1.06	1.00	2.35	1.80	1.63	2.44	1.80	2.02
33	2.99D	0.83	1.15	1.78	2.30	1.13	1.07	2.39	1.84	1.67	2.48	1.84	2.06
34	3.27D	0.86	1.21	1.82	2.35	1.19	1.14	2.42	1.88	1.73	2.52	1.89	2.11
35	3.55D	0.88	1.25	1.86	2.40	1.24	1.22	2.45	1.93	1.78	2.53	1.93	2.15
36	3.83D		1.28	1.89	2.45	1.27	1.26	2.46	1.93	1.79	2.53	1.92	2.15
37	4.11D		1.30	1.90	2.47	1.30	1.28	2.47	1.92	1.79	2.53	1.92	2.15
38	5.05D		1.31	1.92	2.50	1.32	1.33	2.48	1.92	1.80	--	1.92	2.15
39	6.65D		1.32	1.94	2.51	1.33	1.35	2.48	1.92	1.80	--	1.92	2.15
40	8.04D		1.30	1.92	2.50	1.31	1.33	2.46	1.91	1.78	--	1.90	2.14
41	9.60D		1.29	1.91	2.48	1.30	1.31	2.44	1.90	1.76	--	1.89	2.13
42	11.15D		1.27	1.89	2.47	1.28	1.29	2.43	1.88	1.74	2.51	1.87	2.11
43	12.70D		1.26	1.87	2.45	1.26	1.27	2.42	1.87	1.73	2.49	1.86	2.09

Table 5

Average Piezometer Readings, Type 4 Expansion

Piezometer Locations			Run Number*															
No.	Station	Elevation	274	275	277	278	279	280	281	282	283	285	286	287	288	289	290	291
4	15.00U	0.56	4.82	5.22	3.72	3.51	4.02	4.45	4.36	3.77	3.66	4.65	4.32	3.97	3.10	3.65	4.27	3.69
5	8.79U		4.77	5.18	3.68	3.45	3.96	4.40	4.27	3.70	3.54	4.55	4.21	3.86	2.94	3.50	4.10	3.47
6	6.75U		4.76	5.17	3.68	3.44	3.95	4.39	4.26	3.69	3.53	4.53	4.19	3.84	2.91	3.47	4.07	3.43
7	4.79U		4.75	5.16	3.67	3.42	3.94	4.38	4.24	3.68	3.51	4.51	4.17	3.82	2.89	3.44	4.04	3.39
8	2.79U		4.74	5.15	3.66	3.41	3.93	4.37	4.23	3.67	3.49	4.50	4.16	3.80	2.87	3.43	4.03	3.37
9	1.79U		4.73	5.14	3.65	3.39	3.91	4.36	4.21	3.65	3.45	4.46	4.12	3.75	2.82	3.38	3.97	3.29
14	0.08D	0.57	0.16	0.85	0.72	0.30	0.93	1.60	-0.03	0.15	-0.17	1.17	1.35	-0.31	-0.23	0.53	1.06	-0.65
15	0.22D	0.58	0.15	0.84	0.72	0.30	0.93	1.59	-0.03	0.14	-0.17	1.16	1.34	-0.32	-0.24	0.52	1.05	-0.66
16	0.36D	0.60	0.14	0.84	0.72	0.29	0.92	1.58	-0.04	0.14	-0.18	1.15	1.33	-0.33	-0.25	0.51	1.04	-0.67
17	0.50D	0.61	0.13	0.83	0.72	0.28	0.92	1.57	-0.04	0.13	-0.19	1.14	1.33	-0.34	-0.26	0.51	1.04	-0.67
18	0.64D	0.62	0.13	0.82	0.71	0.27	0.91	1.56	-0.05	0.13	-0.20	1.14	1.32	-0.35	-0.26	0.52	1.05	-0.67
19	0.78D	0.64	0.14	0.82	0.71	0.27	0.92	1.56	-0.05	0.13	-0.20	1.15	1.32	-0.35	-0.25	0.53	1.07	-0.65
20	0.92D	0.65	0.14	0.83	0.71	0.27	0.92	1.56	-0.05	0.12	-0.20	1.17	1.33	-0.34	-0.22	0.57	1.10	-0.60
21	1.06D	0.67	0.15	0.85	0.71	0.27	0.93	1.56	-0.04	0.13	-0.18	1.19	1.35	-0.32	-0.15	0.65	1.14	-0.55
22	1.20D	0.68	0.15	0.87	0.72	0.28	0.93	1.57	-0.03	0.14	-0.13	1.23	1.38	-0.26	-0.08	0.72	1.20	-0.45
23	1.34D	0.69	0.16	0.88	0.72	0.29	0.94	1.58	-0.02	0.15	-0.07	1.26	1.41	-0.22	0.00	0.78	1.27	-0.36
24	1.48D	0.71	0.16	0.90	0.73	0.30	0.95	1.59	0.00	0.16	-0.01	1.30	1.45	-0.13	0.06	0.85	1.35	-0.28
25	1.62D	0.72	0.18	0.94	0.74	0.33	0.97	1.63	0.05	0.18	0.04	1.38	1.51	-0.03	0.14	0.96	1.46	-0.15
26	1.76D		0.20	0.95	0.75	0.35	0.99	1.65	0.08	0.20	0.10	1.42	1.57	0.02	0.28	1.03	1.54	-0.05
27	1.90D		0.23	0.98	0.77	0.40	1.04	1.68	0.12	0.25	0.16	1.48	1.64	0.09	0.40	1.15	1.60	0.08
28	2.04D		0.25	1.02	0.79	0.44	1.07	1.72	0.16	0.30	0.24	1.55	1.71	0.15	0.55	1.26	1.66	0.20
29	2.18D		0.30	1.05	0.81	0.50	1.10	1.76	0.21	0.36	0.30	1.62	1.76	0.24	0.67	1.36	1.74	0.35
30	2.46D		0.37	1.15	0.85	0.60	1.20	1.82	0.30	0.42	0.45	1.75	1.85	0.42	0.78	1.50	1.90	0.50
31	2.74D		0.45	1.23	0.90	0.69	1.29	1.94	0.45	0.55	0.55	1.88	1.93	0.58	0.88	1.63	2.08	0.70
32	3.02D		0.57	1.34	0.96	0.85	1.41	2.06	0.58	0.69	0.70	2.05	2.08	0.78	0.98	1.78	2.22	0.87
33	3.30D		0.73	1.45	1.05	0.95	1.56	2.16	0.75	0.82	0.90	2.20	2.23	0.91	1.07	1.88	2.34	1.05
34	3.58D		0.90	1.58	1.16	1.04	1.65	2.26	0.90	0.97	1.05	2.32	2.37	1.03	1.15	1.94	2.42	1.15
35	3.86D		1.04	1.66	1.25	1.14	1.78	2.35	1.05	1.10	1.15	2.41	2.44	1.15	1.23	1.99	2.45	1.23
36	4.80D		1.19	1.82	1.38	1.23	1.84	2.43	1.25	1.21	1.24	2.49	2.46	1.29	1.26	2.00	2.48	1.30
37	6.40D		1.20	1.85	1.40	1.25	1.86	2.44	1.28	1.24	1.26	2.50	2.47	1.30	1.26	2.00	2.49	1.29
38	8.04D		1.20	1.85	1.40	1.24	1.85	2.44	1.28	1.24	1.26	2.49	2.46	1.29	1.26	1.99	2.48	1.28
39	9.60D		1.20	1.85	1.40	1.25	1.84	2.44	1.27	1.23	1.25	2.48	2.45	1.28	1.24	1.97	2.45	1.26
40	11.15D		1.20	1.84	1.40	1.24	1.84	2.43	1.26	1.23	1.24	2.48	2.44	1.27	1.23	1.96	2.44	1.25
41	12.70D		1.20	1.84	1.40	1.23	1.83	2.43	1.25	1.22	1.24	2.46	2.43	1.26	1.21	1.94	2.42	1.23

(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 5 (Concluded)

Piezometer Locations			Run Number															
No.	Station	Elevation	292	293	294	295	296	297	298	299	300	302	303	304	305	306	307	308
4	15.00U	0.56	3.84	2.67	3.19	3.87	2.86	3.06	2.08	2.72	3.30	2.53	3.00	2.39	2.44	2.81	2.22	2.58
5	8.79U		3.63	2.49	3.00	3.67	2.63	2.81	1.87	2.49	3.09	2.18	2.71	2.13	2.14	2.55	1.92	2.28
6	6.75U		3.59	2.44	2.96	3.63	2.60	2.76	1.82	2.45	3.04	2.12	2.65	2.08	2.08	2.47	1.86	2.21
7	4.79U		3.56	2.41	2.91	3.59	2.58	2.71	1.78	2.40	3.00	2.05	2.61	2.02	2.03	2.42	1.81	2.14
8	2.79U		3.54	2.38	2.89	3.56	2.57	2.69	1.76	2.38	2.98	2.02	2.57	2.00	2.00	2.39	1.78	2.11
9	1.79U		3.46	2.30	2.81	3.48	2.44	2.60	1.66	2.29	2.88	1.88	2.45	1.89	1.86	2.27	1.66	1.99
14	0.08D	0.57	-0.74	-0.23	0.42	0.97	-0.48	-0.70	0.05	0.76	1.33	-0.50	1.54	0.92	0.80	2.12	1.49	1.78
15	0.22D	0.58	-0.75	-0.23	0.41	0.97	-0.49	-0.70	0.05	0.78	1.35	-0.47	1.71	1.07	1.00	2.22	1.60	1.90
16	0.36D	0.60	-0.76	-0.22	0.41	0.98	-0.47	-0.70	0.08	0.84	1.38	-0.40	1.86	1.24	1.20	2.29	1.66	1.97
17	0.50D	0.61	-0.76	-0.18	0.41	1.01	-0.43	-0.68	0.17	0.87	1.43	-0.33	2.00	1.40	1.32	2.35	1.74	2.06
18	0.64D	0.62	-0.75	-0.15	0.44	1.05	-0.39	-0.61	0.23	0.95	1.52	-0.20	2.17	1.52	1.46	2.40	1.78	2.10
19	0.78D	0.64	-0.71	-0.10	0.50	1.10	-0.32	-0.55	0.31	1.06	1.62	-0.08	2.24	1.59	1.56	2.45	1.83	2.13
20	0.92D	0.65	-0.67	-0.04	0.60	1.16	-0.21	-0.44	0.41	1.15	1.73	0.05	2.32	1.68	1.66	2.48	1.88	2.19
21	1.06D	0.67	-0.60	0.07	0.70	1.23	-0.12	-0.34	0.52	1.26	1.84	0.20	2.36	1.75	1.73	2.52	1.91	2.23
22	1.20D	0.68	-0.52	0.18	0.78	1.32	0.00	-0.23	0.65	1.35	1.92	0.37	2.40	1.80	1.78	2.55	1.95	2.28
23	1.34D	0.69	-0.45	0.28	0.89	1.40	0.09	-0.15	0.76	1.44	2.01	0.50	2.44	1.84	1.83	2.57	1.98	2.32
24	1.48D	0.71	-0.35	0.37	1.00	1.51	0.20	-0.02	0.85	1.51	2.09	0.63	2.48	1.88	1.87	2.60	2.02	2.37
25	1.62D	0.72	-0.25	0.50	1.09	1.63	0.31	0.12	0.92	1.58	2.18	0.76	2.51	1.93	1.94	2.68	2.08	2.47
26	1.76D		-0.15	0.62	1.19	1.74	0.40	0.23	1.03	1.64	2.22	0.91	2.53	1.94	1.95	2.64	2.03	2.41
27	1.90D		0.00	0.73	1.28	1.84	0.52	0.36	1.10	1.69	2.27	1.02	2.56	1.95	1.96	2.64	2.03	2.41
28	2.04D		0.15	0.81	1.36	1.93	0.62	0.52	1.15	1.75	2.33	1.10	2.58	1.96	1.97	2.63	2.02	2.40
29	2.18D		0.25	0.92	1.47	2.05	0.72	0.64	1.19	1.79	2.37	1.18	2.60	1.97	1.98	2.63	2.02	2.40
30	2.46D		0.36	1.04	1.58	2.16	0.84	0.80	1.23	1.85	2.45	1.23	2.60	1.98	1.99	2.62	2.01	2.39
31	2.74D		0.60	1.13	1.70	2.28	0.96	0.96	1.27	1.91	2.48	1.30	2.61	1.99	2.00	2.62	2.01	2.38
32	3.02D		0.77	1.17	1.77	2.41	1.07	1.07	1.30	1.94	2.52	1.35	2.61	2.00	2.00	2.62	2.01	2.38
33	3.30D		0.95	1.21	1.84	2.45	1.16	1.17	1.32	1.96	2.54	1.38	2.60	2.01	2.01	2.62	2.01	2.37
34	3.58D		1.10	1.25	1.87	2.49	1.23	1.25	1.33	1.97	--	1.40	2.59	2.00	2.01	2.61	2.00	2.36
35	3.86D		1.25	1.30	1.91	2.52	1.27	1.31	1.34	1.98	--	1.43	2.59	1.99	2.02	2.61	2.00	2.35
36	4.80D		1.35	1.35	1.92	2.54	1.33	1.33	1.35	1.99	--	1.44	2.57	1.99	2.01	2.61	1.99	2.34
37	6.40D		1.35	1.34	1.91	2.54	1.33	1.33	1.33	1.98	--	1.44	2.55	1.98	2.00	2.60	1.98	2.33
38	8.04D		1.34	1.33	1.90	2.53	1.32	1.31	1.31	1.96	--	1.41	2.53	1.96	1.97	--	1.96	2.31
39	9.60D		1.31	1.30	1.86	2.51	1.28	1.26	1.27	1.93	2.51	1.36	2.51	1.92	1.93	--	1.92	2.27
40	11.15D		1.30	1.29	1.86	2.50	1.28	1.25	1.26	1.92	2.50	1.34	2.50	1.91	1.93	2.51	1.91	2.26
41	12.70D		1.27	1.27	1.83	2.48	1.24	1.22	1.23	1.89	2.47	1.30	2.47	1.88	1.88	2.48	1.87	2.22

Table 6

Average Piezometer Readings, Type 5 Expansion

Piezometer Locations			Run Number*											
No.	Station	Elevation	335	336	337	338	339	340	341	342	343	344	345	346
4	15.00U	0.56	5.60	5.33	4.74	3.44	4.10	4.66	5.39	3.45	4.02	4.61	4.45	3.55
5	8.79U		5.59	5.31	4.72	3.41	4.07	4.63	5.34	3.39	3.96	4.55	4.37	3.45
6	6.75U		5.58	5.31	4.72	3.40	4.06	4.62	5.33	3.37	3.95	4.53	4.34	3.41
7	4.79U		5.57	5.31	4.72	3.40	4.06	4.62	5.32	3.37	3.94	4.52	4.33	3.41
8	2.79U		5.57	5.31	4.72	3.39	4.05	4.62	5.32	3.36	3.94	4.52	4.32	3.40
9	1.79U		5.57	5.30	4.71	3.38	4.04	4.60	5.30	3.34	3.91	4.50	4.30	3.36
14	0.08D		1.65	1.30	0.76	0.59	1.20	1.92	0.90	0.27	0.95	1.50	-0.05	-0.17
15	0.22D		1.64	1.29	0.75	0.58	1.19	1.92	0.89	0.26	0.94	1.49	-0.06	-0.18
16	0.36D		1.63	1.28	0.74	0.57	1.18	1.91	0.88	0.25	0.93	1.48	-0.07	-0.19
17	0.50D		1.63	1.27	0.74	0.57	1.17	1.91	0.87	0.25	0.92	1.48	-0.08	-0.19
18	0.64D	0.57	1.63	1.27	0.74	0.57	1.16	1.91	0.87	0.24	0.92	1.48	-0.08	-0.18
19	0.78D	0.58	1.64	1.28	0.74	0.57	1.17	1.91	0.87	0.24	0.93	1.49	-0.07	-0.17
20	0.92D	0.59	1.65	1.29	0.75	0.57	1.18	1.91	0.87	0.25	0.94	1.50	-0.06	-0.14
21	1.06D	0.61	1.66	1.31	0.76	0.58	1.19	1.91	0.88	0.26	0.95	1.52	-0.05	-0.12
22	1.20D	0.62	1.67	1.33	0.77	0.59	1.20	1.92	0.89	0.28	0.97	1.55	-0.03	-0.09
23	1.34D	0.64	1.68	1.34	0.78	0.61	1.21	1.92	0.91	0.30	1.00	1.57	-0.01	-0.05
24	1.48D	0.65	1.70	1.35	0.79	0.64	1.23	1.93	0.94	0.35	1.04	1.60	0.03	0.01
25	1.62D	0.67	1.72	1.36	0.80	0.66	1.25	1.95	0.97	0.40	1.08	1.65	0.07	0.10
26	1.76D	0.68	1.75	1.37	0.82	0.68	1.27	1.98	1.01	0.44	1.11	1.70	0.12	0.19
27	1.90D	0.69	1.77	1.39	0.84	0.70	1.28	2.00	1.03	0.47	1.14	1.74	0.18	0.27
28	2.04D	0.71	1.79	1.40	0.86	0.73	1.30	2.02	1.07	0.51	1.17	1.78	0.24	0.32
29	2.18D	0.72	1.81	1.42	0.88	0.75	1.32	2.05	1.09	0.55	1.21	1.85	0.28	0.38
31	2.46D	0.75	1.87	1.50	0.93	0.80	1.36	2.12	1.14	0.62	1.28	1.95	0.42	0.50
33	2.74D	0.78	1.92	1.60	0.99	0.85	1.40	2.16	1.23	0.70	1.36	2.04	0.55	0.61
34	3.02D	0.80	1.96	1.65	1.05	0.88	1.45	2.20	1.28	0.77	1.43	2.08	0.65	0.71
35	3.30D	0.83	2.00	1.71	1.12	0.92	1.49	2.25	1.37	0.83	1.50	2.15	0.75	0.83
36	3.58D	0.86	2.04	1.76	1.16	0.95	1.60	2.30	1.45	0.90	1.60	2.20	0.87	0.94
37	3.86D	0.88	2.10	1.79	1.20	1.00	1.68	2.34	1.53	1.00	1.69	2.26	0.98	1.05
39	4.42D		2.20	1.85	1.30	1.10	1.78	2.43	1.72	1.17	1.80	2.37	1.17	1.20
41	6.96D		2.22	1.88	1.34	1.22	1.82	2.50	1.87	1.21	1.86	2.43	1.25	1.25
42	8.04D		2.22	1.88	1.34	1.21	1.82	2.50	1.87	1.21	1.86	2.43	1.25	1.24
43	9.60D		2.22	1.88	1.34	1.21	1.82	2.50	1.86	1.20	1.85	2.42	1.25	1.24
44	11.15D		2.22	1.88	1.34	1.21	1.82	2.50	1.86	1.20	1.85	2.41	1.25	1.24
45	12.70D		2.26	1.88	1.34	1.20	1.80	2.49	1.86	1.19	1.84	2.41	1.25	1.23

(Continued)

* Refer to Table 1 for flow conditions for each run.

(Sheet 1 of 3)

Table 6 (Continued)

Piezometer Locations			Run Number												
No.	Station	Elevation	347	348	349	350	351	352	353	354	355	356	357	358	359
4	15.00U	0.56	4.20	4.72	3.09	4.04	2.96	3.66	4.22	3.43	3.56	2.35	2.98	3.60	2.52
5	8.79U		4.09	4.62	3.00	3.91	2.80	3.50	4.06	3.23	3.35	2.15	2.80	3.38	2.32
6	6.75U		4.06	4.58	2.98	3.88	2.76	3.45	4.03	3.19	3.30	2.10	2.72	3.32	2.26
7	4.79U		4.05	4.57	2.97	3.87	2.75	3.43	4.00	3.18	3.27	2.07	2.69	3.30	2.23
8	2.79U		4.03	4.56	2.96	3.86	2.74	3.42	3.98	3.16	3.25	2.05	2.67	3.28	2.21
9	1.79U		3.99	4.53	2.93	3.80	2.69	3.35	3.92	3.09	3.16	1.96	2.60	3.19	2.10
14	0.08D		0.47	0.98	0.08	-0.45	-0.42	0.20	0.87	-0.73	-1.00	-0.54	0.02	0.65	-0.70
15	0.22D		0.46	0.97	0.07	-0.46	-0.43	0.19	0.86	-0.74	-1.01	-0.55	0.01	0.65	-0.70
16	0.36D		0.45	0.96	0.06	-0.47	-0.43	0.18	0.85	-0.75	-1.02	-0.51	0.04	0.67	-0.66
17	0.50D		0.44	0.96	0.06	-0.47	-0.43	0.18	0.85	-0.76	-1.00	-0.45	0.07	0.73	-0.63
18	0.64D	0.57	0.44	0.97	0.07	-0.45	-0.42	0.20	0.88	-0.75	-0.98	-0.34	0.17	0.82	-0.54
19	0.78D	0.58	0.45	0.98	0.08	-0.42	-0.38	0.26	0.93	-0.70	-0.92	-0.23	0.30	0.95	-0.41
20	0.92D	0.59	0.48	1.02	0.10	-0.38	-0.30	0.35	0.97	-0.65	-0.85	-0.12	0.42	1.09	-0.30
21	1.06D	0.61	0.52	1.07	0.13	-0.32	-0.20	0.44	1.05	-0.54	-0.76	0.00	0.54	1.15	-0.15
22	1.20D	0.62	0.58	1.09	0.18	-0.28	-0.11	0.53	1.17	-0.35	-0.64	0.12	0.67	1.30	0.00
23	1.34D	0.64	0.63	1.13	0.24	-0.21	0.00	0.65	1.31	-0.20	-0.50	0.25	0.80	1.41	0.12
24	1.48D	0.65	0.70	1.20	0.30	-0.15	0.10	0.75	1.39	-0.08	-0.32	0.36	0.89	1.55	0.22
25	1.62D	0.67	0.80	1.30	0.35	-0.07	0.22	0.85	1.48	0.05	-0.15	0.47	1.00	1.65	0.35
26	1.76D	0.68	0.90	1.38	0.45	0.01	0.35	0.95	1.57	0.15	0.00	0.55	1.11	1.72	0.45
27	1.90D	0.69	0.97	1.48	0.52	0.08	0.41	1.07	1.65	0.22	0.10	0.64	1.19	1.80	0.54
28	2.04D	0.71	1.02	1.57	0.57	0.14	0.50	1.15	1.73	0.35	0.24	0.69	1.26	1.90	0.64
29	2.18D	0.72	1.07	1.67	0.62	0.22	0.60	1.24	1.80	0.45	0.35	0.77	1.34	1.97	0.72
31	2.46D	0.75	1.15	1.80	0.73	0.40	0.73	1.40	1.92	0.57	0.52	0.85	1.44	2.06	0.87
33	2.74D	0.78	1.32	1.90	0.85	0.57	0.85	1.55	2.08	0.75	0.68	0.95	1.52	2.15	0.98
34	3.02D	0.80	1.40	1.97	0.90	0.70	0.90	1.60	2.15	0.86	0.75	1.00	1.60	2.19	1.05
35	3.30D	0.83	1.51	2.08	0.95	0.83	0.98	1.70	2.24	0.96	0.86	1.08	1.68	2.23	1.12
36	3.58D	0.86	1.62	2.21	1.00	0.95	1.06	1.78	2.33	1.08	0.98	1.15	1.72	2.30	1.20
37	3.86D	0.88	1.68	2.30	1.07	1.06	1.15	1.84	2.40	1.15	1.06	1.19	1.77	2.36	1.24
39	4.42D		1.84	2.40	1.22	1.22	1.25	1.92	2.50	1.25	1.22	1.27	1.84	2.45	1.31
41	6.96D		1.91	2.42	1.26	1.28	1.27	1.92	2.52	1.34	1.27	1.29	1.88	2.51	1.33
42	8.04D		1.90	2.41	1.25	1.27	1.26	1.91	2.51	1.33	1.26	1.27	1.86	2.50	1.31
43	9.60D		1.90	2.40	1.25	1.27	1.25	1.90	2.50	1.32	1.25	1.26	1.85	2.49	1.30
44	11.15D		1.89	2.40	1.24	1.26	1.24	1.89	2.49	1.31	1.24	1.25	1.84	2.48	1.29
45	12.70D		1.88	2.39	1.24	1.25	1.23	1.88	2.48	1.30	1.23	1.24	1.83	2.46	1.28

(Continued)

Table 6 (Concluded)

Piezometer Locations			Run Number											
No.	Station	Elevation	360	361	362	363	364	365	366	367	368	369	370	371
4	15.00U	0.56	2.69	1.79	2.40	3.03	1.75	2.06	2.63	2.01	2.06	2.50	1.92	1.92
5	8.79U		2.44	1.55	2.19	2.79	1.53	1.74	2.40	1.76	1.77	2.20	1.67	1.62
6	6.75U		2.37	1.49	2.12	2.72	1.46	1.64	2.33	1.68	1.69	2.15	1.59	1.52
7	4.79U		2.34	1.46	2.09	2.69	1.42	1.61	2.30	1.65	1.65	2.11	1.55	1.48
8	2.79U		2.32	1.44	2.05	2.67	1.41	1.58	2.27	1.63	1.62	2.08	1.53	1.45
9	1.79U		2.20	1.35	1.96	2.60	1.30	1.41	2.15	1.52	1.47	1.94	1.41	1.31
14	0.08D		-1.05	-0.25	0.32	1.00	-0.50	-1.00	1.15	0.51	0.35	1.80	1.24	1.09
15	0.22D		-1.05	-0.26	0.31	0.98	-0.52	-1.02	1.36	0.72	0.62	1.82	1.26	1.12
16	0.36D		-1.00	-0.20	0.37	1.02	-0.45	-0.92	1.63	0.98	0.85	1.80	1.23	1.09
17	0.50D		-0.95	-0.05	0.43	1.16	-0.35	-0.75	1.77	1.11	1.05	1.78	1.22	1.07
18	0.64D	0.57	-0.84	0.08	0.71	1.32	-0.15	-0.53	1.89	1.20	1.15	1.85	1.29	1.15
19	0.78D	0.58	-0.68	0.22	0.84	1.48	0.02	-0.25	1.94	1.28	1.22	1.93	1.39	1.24
20	0.92D	0.59	-0.55	0.37	0.97	1.60	0.15	-0.08	1.99	1.33	1.29	1.98	1.43	1.31
21	1.06D	0.61	-0.40	0.47	1.10	1.70	0.30	0.10	2.04	1.38	1.34	2.02	1.47	1.36
22	1.20D	0.62	-0.18	0.58	1.20	1.82	0.43	0.22	2.08	1.42	1.39	2.08	1.53	1.42
23	1.34D	0.64	-0.03	0.69	1.28	1.93	0.53	0.35	2.12	1.45	1.44	2.12	1.56	1.46
24	1.48D	0.65	0.05	0.76	1.34	2.00	0.62	0.47	2.16	1.50	1.48	2.15	1.60	1.51
25	1.62D	0.67	0.17	0.82	1.41	2.05	0.67	0.57	2.20	1.55	1.52	2.18	1.63	1.55
26	1.76D	0.68	0.28	0.90	1.47	2.10	0.74	0.65	2.23	1.58	1.55	2.22	1.66	1.59
27	1.90D	0.69	0.40	0.95	1.52	2.15	0.81	0.70	2.26	1.61	1.59	2.25	1.69	1.62
28	2.04D	0.71	0.50	0.97	1.56	2.18	0.85	0.75	2.28	1.64	1.63	2.28	1.72	1.65
29	2.18D	0.72	0.59	1.02	1.61	2.22	0.89	0.80	2.31	1.67	1.66	2.30	1.75	1.68
31	2.46D	0.75	0.72	1.09	1.67	2.27	0.98	0.94	2.35	1.73	1.72	2.35	1.81	1.75
33	2.74D	0.78	0.85	1.15	1.73	2.34	1.04	1.03	2.39	1.78	1.77	2.39	1.86	1.82
34	3.02D	0.80	0.92	1.20	1.76	2.40	1.08	1.10	2.43	1.83	1.83	2.43	1.90	1.86
35	3.30D	0.83	1.00	1.24	1.79	2.44	1.12	1.15	2.48	1.87	1.87	2.47	1.94	1.90
36	3.58D	0.86	1.10	1.28	1.82	2.46	1.17	1.22	2.52	1.91	1.92	2.50	1.98	1.95
37	3.86D	0.88	1.19	1.31	1.85	2.49	1.21	1.30	--	1.94	1.95	2.53	2.01	1.99
39	4.42D		1.28	1.32	1.88	2.52	1.23	1.36	--	1.93	1.95	2.52	2.00	1.99
41	6.96D		1.31	1.32	1.92	2.53	1.25	1.40	--	1.93	1.96	2.52	2.00	1.99
42	8.04D		1.29	1.30	1.91	2.52	1.23	1.37	--	1.91	1.93	2.51	1.98	1.97
43	9.60D		1.27	1.29	1.90	2.51	1.22	1.35	--	1.90	1.92	2.50	1.97	1.96
44	11.15D		1.26	1.28	1.88	2.50	1.20	1.33	2.51	1.88	1.90	2.48	1.96	1.95
45	12.70D		1.25	1.27	1.87	2.49	1.19	1.31	2.50	1.86	1.88	2.46	1.95	1.94

(Sheet 3 of 3)

Table 7

Average Piezometer Readings, Type 6 Expansion

Piezometer Locations			Run Number*														
No.	Station	Elevation	372	373	374	375	376	377	378	379	380	381	397	398	399	382	383
4	15.00U	0.56	3.36	3.77	4.92	4.55	3.75	4.67	2.45	3.81	2.84	3.93	4.07	3.58	2.96	3.28	3.44
5	8.79U		3.33	3.74	4.88	4.51	3.70	4.60	2.42	3.70	2.75	3.90	3.89	3.45	3.85	3.13	3.24
6	6.75U		3.33	3.73	4.87	4.50	3.68	4.58	2.41	3.67	2.73	3.89	3.85	3.41	2.82	3.09	3.19
7	4.79U		3.32	3.73	4.87	4.49	3.67	4.57	2.41	3.65	2.72	3.87	3.82	3.40	2.81	3.07	3.17
8	2.79U		3.32	3.72	4.86	4.49	3.66	4.56	2.40	3.66	2.71	3.86	3.80	3.38	2.80	3.05	3.15
9	1.79U		3.31	3.71	4.85	4.47	3.64	4.54	2.39	3.61	2.68	3.81	3.73	3.32	2.76	2.98	3.06
14	0.08D		0.35	1.03	0.75	0.88	0.55	0.24	0.63	0.14	-0.17	-0.21	-0.55	-0.33	-0.10	-0.10	-1.15
15	0.22D		0.34	1.02	0.74	0.87	0.54	0.23	0.62	0.12	-0.20	-0.22	-0.57	-0.35	-0.11	-0.13	-1.16
16	0.36D		0.33	1.01	0.73	0.86	0.53	0.22	0.61	0.10	-0.22	-0.23	-0.59	-0.36	-0.12	-0.14	-1.17
17	0.50D		0.32	1.00	0.72	0.85	0.52	0.21	0.61	0.09	-0.23	-0.24	-0.58	-0.36	-0.13	-0.13	-1.17
18	0.64D		0.31	0.99	0.71	0.84	0.51	0.20	0.61	0.08	-0.22	-0.24	-0.50	-0.35	-0.13	-0.10	-1.1[illegible]
19	0.78D		0.32	0.99	0.72	0.83	0.51	0.21	0.61	0.09	-0.20	-0.24	-0.42	-0.30	-0.10	-0.05	-1.10
20	0.92D		0.33	1.00	0.74	0.85	0.52	0.23	0.63	0.13	-0.16	-0.21	-0.26	-0.23	-0.04	0.04	-0.96
21	1.06D		0.35	1.01	0.76	0.89	0.55	0.27	0.65	0.19	-0.10	-0.10	-0.12	-0.11	0.04	0.14	-0.78
22	1.20D		0.37	1.03	0.78	0.92	0.60	0.33	0.67	0.27	-0.02	0.01	0.08	0.00	0.19	0.27	-0.60
23	1.34D		0.40	1.05	0.83	0.95	0.65	0.39	0.72	0.37	0.05	0.13	0.28	0.16	0.32	0.45	-0.35
24	1.48D		0.45	1.07	0.86	1.00	0.71	0.50	0.76	0.50	0.15	0.28	0.50	0.36	0.45	0.66	-0.15
25	1.62D		0.50	1.10	0.91	1.04	0.80	0.60	0.80	0.65	0.24	0.42	0.70	0.53	0.55	0.82	0.02
26	1.76D	0.57	0.55	1.14	0.97	1.07	0.86	0.71	0.85	0.75	0.35	0.58	0.82	0.62	0.66	0.92	0.14
27	1.90D	0.58	0.59	1.19	1.01	1.12	0.93	0.82	0.89	0.85	0.42	0.66	0.95	0.73	0.77	1.03	0.25
28	2.04D	0.60	0.62	1.24	1.09	1.21	1.00	0.92	0.94	0.98	0.50	0.77	1.05	0.85	0.88	1.15	0.42
29	2.18D	0.61	0.67	1.29	1.16	1.27	1.06	1.00	0.98	1.06	0.60	0.85	1.12	0.95	0.95	1.21	0.55
30	2.32D	0.62	0.72	1.33	1.22	1.33	1.12	1.07	1.02	1.12	0.67	0.94	1.22	1.03	1.00	1.30	0.63
31	2.46D	0.64	0.75	1.36	1.27	1.36	1.17	1.12	1.05	1.20	0.75	1.05	1.28	1.10	1.05	1.36	0.70
32	2.60D	0.65	0.80	1.40	1.33	1.42	1.23	1.20	1.08	1.30	0.82	1.14	1.35	1.16	1.10	1.42	0.76
33	2.74D	0.67	0.84	1.45	1.39	1.45	1.30	1.30	1.12	1.38	0.87	1.20	1.40	1.22	1.15	1.47	0.83
34	2.88D	0.68	0.89	1.49	1.44	1.48	1.35	1.38	1.15	1.45	0.93	1.27	1.45	1.27	1.20	1.52	0.95
35	3.02D	0.69	0.93	1.53	1.51	1.51	1.40	1.45	1.17	1.52	0.97	1.34	1.50	1.32	1.24	1.57	1.01
36	3.16D	0.71	0.96	1.56	1.57	1.56	1.45	1.51	1.19	1.57	1.00	1.40	1.55	1.36	1.27	1.61	1.09
37	3.30D	0.72	0.99	1.60	1.62	1.61	1.50	1.56	1.20	1.63	1.04	1.47	1.60	1.43	1.32	1.65	1.15
38	3.44D	0.74	1.02	1.63	1.66	1.65	1.55	1.59	1.21	1.67	1.06	1.52	1.65	1.46	1.35	1.69	1.18
39	3.58D	0.75	1.05	1.66	1.70	1.69	1.57	1.62	1.23	1.70	1.08	1.57	1.71	1.52	1.38	1.72	1.25
40	3.72D	0.76	1.07	1.68	1.74	1.73	1.60	1.67	1.24	1.72	1.13	1.63	1.74	1.55	1.41	1.75	1.29
41	3.86D	0.78	1.09	1.70	1.77	1.75	1.63	1.70	1.25	1.75	1.14	1.66	1.77	1.64	1.44	1.77	1.34
42	4.14D	0.81	1.12	1.72	1.81	1.78	1.65	1.74	1.26	1.77	1.16	1.69	1.81	1.68	1.47	1.79	1.37
43	4.42D	0.83	1.13	1.73	1.83	1.81	1.67	1.78	1.27	1.79	1.18	1.74	1.85	1.72	1.50	1.82	1.42
44	4.70D	0.86	1.14	1.74	1.85	1.84	1.68	1.80	1.28	1.82	1.21	1.76	1.88	1.76	1.53	1.84	1.48
45	4.98D	0.88	1.15	1.75	1.86	1.85	1.70	1.82	1.29	1.83	1.22	1.77	1.90	1.77	1.54	1.86	1.50
46	5.26D		1.15	1.75	1.86	1.85	1.70	1.83	1.29	1.84	1.22	1.77	1.90	1.77	1.54	1.87	1.51
47	5.54D		1.15	1.74	1.86	1.85	1.70	1.84	1.29	1.84	1.22	1.77	1.90	1.77	1.54	1.87	1.51
48	6.48D		1.15	1.74	1.85	1.85	1.70	1.85	1.29	1.84	1.21	1.76	1.88	1.76	1.53	1.87	1.49
49	8.04D		1.15	1.73	1.85	1.85	1.70	1.84	1.29	1.83	1.20	1.75	1.87	1.74	1.52	1.85	1.48
50	9.60D		1.15	1.73	1.85	1.85	1.70	1.84	1.28	1.82	1.19	1.74	1.87	1.73	1.51	1.84	1.47
51	11.15D		1.15	1.73	1.84	1.85	1.70	1.83	1.28	1.82	1.18	1.73	1.85	1.72	1.49	1.83	1.46
52	12.70D		1.15	1.73	1.84	1.85	1.70	1.83	1.28	1.81	1.18	1.73	1.85	1.71	1.48	1.82	1.45

(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 7 (Concluded)

Piezometer Locations No.	Station	Elevation	384	400	401	402	385	386	387	388	389	390	391	392	393	394	395
			Run Number														
[illegible]	15.00D	0.56	2.62	3.45	2.93	2.42	2.78	2.95	2.59	2.16	2.46	2.40	2.22	2.46	2.55	2.40	2.24
5	8.79D		2.50	3.21	2.72	2.25	2.57	2.68	2.44	1.94	2.15	2.14	1.96	2.19	2.31	2.11	1.90
6	6.79D		2.47	3.15	2.66	2.20	2.52	2.62	2.40	1.88	2.08	2.08	1.89	2.11	2.25	2.05	1.80
[illegible]	4.79D		2.46	3.12	2.64	2.18	2.51	2.58	2.37	1.85	2.03	2.04	1.85	2.07	2.21	2.00	1.75
[illegible]	2.79D		2.44	3.10	2.62	2.16	2.49	2.56	2.35	1.83	2.01	2.01	1.82	2.04	2.19	1.97	1.72
[illegible]	1.79D		2.38	2.99	2.54	2.10	2.40	2.45	2.29	1.73	1.87	1.90	1.70	1.90	2.08	1.84	1.55
[illegible]	0.08D		-0.31	-0.70	-0.65	-0.57	-0.17	-0.81	0.40	0.08	-0.20	0.03	0.71	0.78	1.17	1.70	1.39
[illegible]	0.22D		-0.32	-0.71	-0.66	-0.58	-0.18	-0.82	0.39	0.06	-0.22	0.01	0.98	1.07	1.41	1.73	1.43
[illegible]	0.36D		-0.33	-0.70	-0.66	-0.58	-0.16	-0.79	0.40	0.12	-0.15	0.08	1.18	1.36	1.61	1.75	1.45
17	0.50D		-0.33	-0.65	-0.61	-0.57	-0.12	-0.71	0.44	0.30	0.03	0.28	1.32	1.53	1.75	1.77	1.47
18	0.64D		-0.30	-0.60	-0.54	-0.54	-0.04	-0.61	0.50	0.43	0.25	0.50	1.37	1.60	1.80	1.75	1.44
19	0.78D		-0.25	-0.47	-0.42	-0.44	0.10	-0.40	0.63	0.70	0.50	0.62	1.41	1.61	1.81	1.73	1.42
20	0.92D		-0.16	-0.29	-0.26	-0.33	0.30	-0.15	0.75	0.85	0.75	0.88	1.42	1.62	1.82	1.72	1.41
21	1.06D		-0.08	-0.03	-0.05	-0.20	0.51	0.05	0.92	0.95	0.92	1.07	1.42	1.63	1.83	1.72	1.42
22	1.20D		0.05	0.20	0.15	0.00	0.70	0.32	1.04	1.05	0.98	1.16	1.42	1.63	1.79	1.69	1.38
23	1.34D		0.15	0.40	0.31	0.20	0.88	0.50	1.15	1.08	1.06	1.21	1.42	1.62	1.81	1.70	1.39
24	1.48D		0.30	0.58	0.45	0.35	1.03	0.65	1.25	1.11	1.08	1.23	1.40	1.58	1.79	1.66	1.35
25	1.62D		0.47	0.75	0.60	0.48	1.10	0.79	1.35	1.12	1.12	1.25	1.39	1.56	1.78	1.64	1.32
26	1.76D	0.57	0.60	0.91	0.72	0.60	1.17	0.90	1.40	1.14	1.14	1.27	1.42	1.59	1.80	1.67	1.37
27	1.90D	0.58	0.68	1.05	0.82	0.68	1.25	1.02	1.45	1.22	1.22	1.35	1.52	1.70	1.90	1.79	1.51
28	2.04D	0.60	0.77	1.15	0.92	0.75	1.31	1.12	1.50	1.27	1.30	1.41	1.57	1.77	1.95	1.85	1.59
29	2.18D	0.61	0.86	1.25	1.01	0.80	1.35	1.17	1.55	1.31	1.35	1.46	1.62	1.82	1.99	1.90	1.63
30	2.32D	0.62	0.91	1.33	1.08	0.85	1.39	1.23	1.59	1.36	1.40	1.52	1.67	1.87	2.02	1.95	1.69
31	2.46D	0.64	0.94	1.40	1.11	0.90	1.44	1.26	1.62	1.39	1.45	1.45	1.69	1.90	2.04	1.98	1.72
32	2.60D	0.65	0.98	1.47	1.16	0.94	1.48	1.30	1.65	1.43	1.50	1.59	1.72	1.95	2.08	2.02	1.77
33	2.74D	0.67	1.03	1.52	1.20	0.98	1.51	1.35	1.68	1.45	1.55	1.63	1.74	1.98	2.11	2.04	1.80
34	2.88D	0.68	1.05	1.55	1.24	1.02	1.55	1.41	1.71	1.48	1.59	1.65	1.77	2.01	2.14	2.07	1.85
35	3.02D	0.69	1.10	1.59	1.29	1.06	1.58	1.47	1.74	1.51	1.63	1.70	1.79	2.04	2.17	2.10	1.88
36	3.16D	0.71	1.14	1.62	1.33	1.10	1.61	1.50	1.76	1.54	1.66	1.73	1.82	2.07	2.19	2.12	1.91
37	3.30D	0.72	1.18	1.65	1.36	1.12	1.64	1.54	1.78	1.56	1.69	1.75	1.85	2.09	2.21	2.15	1.95
38	3.44D	0.74	1.21	1.69	1.39	1.14	1.66	1.58	1.80	1.58	1.72	1.77	1.88	2.13	2.23	2.18	1.98
39	3.58D	0.75	1.23	1.74	1.42	1.16	1.69	1.61	1.82	1.61	1.74	1.80	1.91	2.16	2.25	2.20	2.01
40	3.72D	0.76	1.26	1.78	1.45	1.18	1.73	1.66	1.85	1.63	1.77	1.83	1.93	2.19	2.27	2.23	2.04
41	3.86D	0.78	1.29	1.81	1.48	1.21	1.76	1.69	1.87	1.66	1.80	1.86	1.96	2.22	2.29	2.25	2.07
42	4.14D	0.81	1.31	1.86	1.53	1.24	1.80	1.74	1.90	1.70	1.86	1.90	2.00	2.26	2.33	2.29	2.11
43	4.42D	0.83	1.34	1.90	1.57	1.28	1.85	1.78	1.93	1.74	1.91	1.94	2.04	2.30	2.37	2.33	2.16
44	4.70D	0.86	1.38	1.94	1.62	1.32	1.89	1.82	1.94	1.77	1.96	1.98	2.08	2.35	2.40	2.37	2.21
45	4.98D	0.88	1.39	1.97	1.66	1.36	1.92	1.85	1.95	1.80	2.00	2.01	2.12	2.38	2.44	2.41	2.24
46	5.26D		1.39	1.98	1.67	1.36	1.92	1.86	1.95	1.79	1.99	2.01	2.11	2.37	2.43	2.40	2.23
47	5.54D		1.39	1.99	1.67	1.35	1.92	1.86	1.95	1.79	1.99	2.00	2.10	2.37	2.43	2.40	2.23
48	6.48D		1.38	2.00	1.66	1.34	1.92	1.86	1.95	1.79	1.99	2.00	2.10	2.37	2.43	2.40	2.23
49	8.04D		1.38	1.98	1.65	1.33	1.90	1.84	1.94	1.78	1.97	1.99	2.09	2.35	2.41	2.38	2.22
50	9.60D		1.37	1.97	1.64	1.32	1.88	1.82	1.92	1.77	1.96	1.98	2.08	2.34	2.40	2.37	2.21
51	11.15D		1.37	1.95	1.62	1.31	1.87	1.80	1.91	1.76	1.94	1.96	2.06	2.32	2.39	2.36	2.20
52	12.70D		1.36	1.93	1.60	1.29	1.86	1.78	1.90	1.75	1.92	1.94	2.04	2.30	2.37	2.34	2.17

Table 8

Average Piezometer Readings, Type 7 Expansion

Piezometer Locations			Run Number*														
No.	Station	Elevation	430	431	432	427	428	429	424	425	426	421	422	433	418	419	420
4	15.00U	0.56	4.92	4.28	3.77	4.36	3.23	2.37	3.85	3.55	2.76	3.86	3.41	2.87	3.58	3.18	2.68
5	8.79U		4.88	4.23	3.74	4.27	3.17	2.35	3.70	3.43	2.67	3.66	3.25	2.74	3.35	3.01	2.52
6	6.75U		4.87	4.22	3.74	4.25	3.16	2.33	3.68	3.41	2.63	3.62	3.21	2.71	3.30	2.98	2.49
7	4.79U		4.86	4.21	3.73	4.24	3.15	2.33	3.66	3.39	2.62	3.59	3.19	2.69	3.26	2.96	2.47
8	2.79U		4.85	4.21	3.72	4.22	3.14	2.32	3.64	3.38	2.61	3.57	3.17	2.67	3.23	2.94	2.45
9	1.79U		4.83	4.20	3.71	4.20	3.12	2.30	3.59	3.33	2.58	3.52	3.10	2.62	3.14	2.87	2.39
14	0.08D		0.33	0.62	0.86	-0.07	0.21	0.39	-0.37	0.00	-0.15	-0.65	-0.40	-0.12	-1.10	-0.25	-0.27
15	0.22D		0.33	0.60	0.85	-0.09	0.19	0.38	-0.41	-0.02	-0.17	-0.67	-0.43	-0.14	-1.15	-0.27	-0.30
16	0.36D		0.31	0.58	0.84	-0.10	0.18	0.37	-0.44	-0.02	-0.19	-0.68	-0.45	-0.17	-1.19	-0.26	-0.28
17	0.50D		0.30	0.57	0.83	-0.11	0.17	0.35	-0.47	-0.01	-0.21	-0.66	-0.42	-0.16	-1.17	-0.22	-0.26
18	0.64D		0.29	0.58	0.82	-0.08	0.16	0.34	-0.44	0.01	-0.19	-0.62	-0.38	-0.13	-1.12	-0.18	-0.22
19	0.78D		0.33	0.59	0.83	-0.07	0.18	0.35	-0.39	0.03	-0.17	-0.58	-0.34	-0.09	-1.00	-0.12	-0.17
20	0.92D		0.34	0.61	0.84	-0.04	0.21	0.36	-0.32	0.06	-0.14	-0.46	-0.28	-0.03	-0.86	0.04	-0.06
21	1.06D		0.38	0.64	0.87	0.02	0.27	0.41	-0.20	0.19	-0.08	-0.34	-0.12	0.09	-0.65	0.17	0.02
22	1.20D		0.40	0.68	0.89	0.10	0.32	0.43	-0.10	0.31	-0.02	-0.14	0.03	0.23	-0.38	0.36	0.18
23	1.34D		0.42	0.73	0.93	0.21	0.37	0.44	-0.03	0.41	0.04	0.06	0.11	0.36	-0.22	0.55	0.34
24	1.48D		0.49	0.81	0.96	0.31	0.43	0.48	0.12	0.56	0.15	0.28	0.31	0.49	0.04	0.71	0.46
25	1.62D		0.57	0.86	1.01	0.40	0.51	0.52	0.41	0.74	0.37	0.44	0.47	0.63	0.28	0.87	0.58
26	1.76D		0.61	0.91	1.06	0.52	0.58	0.58	0.66	0.85	0.45	0.56	0.67	0.77	0.48	0.99	0.72
27	1.90D		0.68	0.97	1.11	0.61	0.66	0.63	0.79	0.98	0.53	0.73	0.78	0.87	0.66	1.13	0.84
28	2.04D		0.80	1.07	1.19	0.82	0.75	0.68	0.87	1.08	0.62	0.84	0.94	0.93	0.78	1.17	0.90
29	2.18D		0.87	1.12	1.23	0.91	0.81	0.74	0.98	1.18	0.68	1.03	1.07	1.00	0.90	1.28	0.97
30	2.45D		1.11	1.26	1.36	1.12	0.95	0.87	1.21	1.37	1.83	1.19	1.19	1.12	1.04	1.37	1.07
31	2.73D		1.33	1.33	1.51	1.28	1.12	0.97	1.31	1.48	0.97	1.26	1.26	1.21	1.14	1.39	1.12
32	3.01D		1.48	1.47	1.63	1.40	1.22	1.04	1.42	1.56	1.03	1.38	--	1.25	1.21	1.43	1.16
33	3.29D		1.58	1.59	1.67	1.50	1.28	1.08	1.47	1.58	1.08	1.41	1.35	1.31	1.24	1.45	1.18
35	3.71D	0.57	1.67	1.64	1.69	1.54	1.33	1.10	1.48	1.59	1.11	1.43	1.37	1.30	1.22	1.47	1.19
38	4.13D	0.61	1.72	1.70	1.73	1.61	1.36	1.13	1.57	1.66	1.17	1.52	1.48	1.38	1.36	1.58	1.23
41	4.55D	0.65	1.74	1.73	1.74	1.64	1.39	1.15	1.62	1.71	1.21	1.59	1.55	1.43	1.48	1.64	1.30
44	4.97D	0.69	1.76	1.74	1.75	1.67	1.41	1.17	1.66	1.75	1.24	1.65	1.61	1.47	1.57	1.70	1.35
47	5.39D	0.74	1.77	1.75	1.76	1.69	1.43	1.18	1.70	1.77	1.27	1.69	1.67	1.50	1.63	1.74	1.39
50	5.81D	0.78	1.78	1.76	1.77	1.71	1.44	1.20	1.73	1.79	1.29	1.73	1.70	1.53	1.67	1.77	1.42
51	6.09D	0.81	1.79	1.76	1.77	1.72	1.45	1.20	1.75	1.81	1.30	1.76	1.73	1.55	1.71	1.80	1.45
52	6.37D	0.83	1.79	1.77	1.78	1.73	1.46	1.21	1.77	1.84	1.31	1.79	1.76	1.57	1.74	1.82	1.47
53	6.65D	0.86	1.79	1.77	1.78	1.74	1.47	1.21	1.79	1.86	1.32	1.82	1.78	1.58	1.78	1.85	1.49
54	8.02D	0.88	1.79	1.77	1.78	1.74	1.47	1.20	1.78	1.85	1.32	1.81	1.77	1.59	1.76	1.84	1.48
55	9.57D	0.88	1.79	1.77	1.78	1.74	1.46	1.20	1.77	1.84	1.31	1.80	1.77	1.58	1.75	1.83	1.47
56	11.12D	0.88	1.79	1.77	1.78	1.73	1.45	1.20	1.76	1.83	1.30	1.79	1.76	1.57	1.74	1.82	1.46
57	12.67D	0.88	1.78	1.76	1.76	1.72	1.44	1.20	1.75	1.82	1.29	1.76	1.75	1.56	1.72	1.81	1.36

(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 8 (Concluded)

Piezometer Locations			Run Number														
No.	Station	Elevation	415	416	417	412	413	414	409	410	411	406	407	408	403	404	405
4	15.00U	0.56	3.28	2.73	2.36	2.89	2.96	2.73	2.27	2.77	2.48	2.26	2.06	2.59	2.25	2.48	2.10
5	8.79U		3.04	2.52	2.17	2.63	2.74	2.67	2.05	2.50	2.19	1.95	1.83	2.31	2.00	2.18	1.78
6	6.75U		2.98	2.47	2.13	2.58	2.68	2.51	1.98	2.44	2.10	1.87	1.75	2.22	1.92	2.11	1.68
7	4.79U		2.96	2.46	2.10	2.52	2.66	2.48	1.95	2.41	2.06	1.84	1.72	2.18	1.89	2.09	1.64
8	2.79U		2.93	2.43	2.08	2.50	2.62	2.47	1.92	2.37	2.03	1.81	1.70	2.15	1.86	2.05	1.61
9	1.79U		2.86	2.32	2.06	2.40	2.52	2.39	1.82	2.26	1.91	1.67	1.59	2.02	1.74	1.92	1.45
14	0.08D		-0.95	-0.65	-0.66	-0.87	-0.05	0.35	0.23	0.41	-0.25	0.58	0.65	0.90	1.61	1.78	1.28
15	0.22D		-0.93	-0.66	-0.67	-0.88	-0.04	0.36	0.21	0.39	-0.27	0.85	0.85	1.14	1.65	1.81	1.32
16	0.36D		-0.88	-0.64	-0.63	-0.87	-0.02	0.38	0.29	0.49	-0.18	1.10	1.10	1.41	1.66	1.82	1.33
17	0.50D		-0.84	-0.62	-0.56	-0.78	0.01	0.42	0.44	0.68	0.03	1.25	1.24	1.61	1.69	1.82	1.33
18	0.64D		-0.72	-0.56	-0.50	-0.65	0.10	0.48	0.62	0.86	0.25	1.33	1.31	1.69	1.68	1.82	1.33
19	0.78D		-0.65	-0.43	-0.40	-0.50	0.25	0.57	0.90	1.10	0.53	1.37	1.34	1.71	1.67	1.82	1.32
20	0.92D		-0.48	-0.27	-0.31	-0.20	0.45	0.68	1.08	1.30	0.73	1.38	1.35	1.73	1.66	1.82	1.31
21	1.06D		-0.27	-0.12	-0.18	0.00	0.65	0.95	1.15	1.41	0.90	1.39	1.36	1.74	1.66	1.82	1.31
22	1.20D		0.04	0.08	0.02	0.22	0.86	1.14	1.23	1.50	1.01	1.39	1.37	1.75	1.66	1.82	1.33
23	1.34D		0.22	0.32	0.24	0.36	1.02	1.22	1.28	1.54	1.06	1.39	1.36	1.73	1.66	1.82	1.30
24	1.48D		0.43	0.46	0.38	0.54	1.16	1.33	1.29	1.58	1.11	1.39	1.36	1.73	1.65	1.80	1.30
25	1.62D		0.62	0.57	0.51	0.75	1.28	1.41	1.30	1.60	1.14	1.38	1.36	1.72	1.65	1.79	1.29
26	1.76D		0.75	0.72	0.61	0.84	1.36	1.47	1.31	1.62	1.15	1.38	1.36	1.71	1.64	1.80	1.29
27	1.90D		0.87	0.78	0.78	0.91	1.43	1.49	1.32	1.63	1.16	1.38	1.35	1.71	1.64	1.78	1.28
28	2.04D		0.96	0.83	0.75	0.97	1.46	1.53	1.33	1.64	1.18	1.37	1.34	1.70	1.63	1.77	1.27
29	2.18D		1.04	0.88	0.81	1.01	1.52	1.56	1.34	1.65	1.19	1.37	1.34	1.70	1.63	1.78	1.27
30	2.45D		1.12	0.97	0.84	1.05	1.54	1.58	1.34	1.66	1.20	1.37	1.34	1.70	1.62	1.77	1.26
31	2.73D		1.17	1.03	0.87	1.09	1.57	1.60	1.33	1.66	1.20	1.36	1.33	1.69	1.61	1.75	1.24
32	3.01D		1.20	1.06	0.90	1.12	1.59	1.61	1.33	1.67	1.20	1.35	1.32	1.68	1.62	1.74	1.23
33	3.29D		1.24	1.08	0.92	1.13	1.58	1.62	1.32	1.66	1.19	1.33	1.31	1.67	1.60	1.73	1.21
35	3.71D	0.57	1.26	1.09	0.91	1.13	1.56	1.58	1.29	1.65	1.17	1.31	--	1.66	--	--	--
38	4.13D	0.61	1.43	1.23	1.03	--	1.71	1.74	--	--	--	--	--	--	--	--	--
41	4.55D	0.65	1.52	1.31	1.09	--	1.81	1.82	--	--	--	--	--	--	--	--	--
44	4.97D	0.69	1.61	1.37	1.14	--	1.89	1.86	--	--	--	--	--	--	--	--	--
47	5.39D	0.74	1.67	1.43	1.19	--	1.94	1.92	--	--	--	--	--	--	--	--	--
50	5.81D	0.78	1.74	1.47	1.24	--	1.98	1.96	--	--	--	--	--	--	--	--	--
51	6.09D	0.81	1.78	1.51	1.29	1.73	2.05	1.99	1.80	2.22	1.83	1.95	1.81	2.28	2.10	2.28	1.92
52	6.37D	0.83	1.83	1.51	1.29	1.77	2.08	2.02	1.84	2.26	1.88	2.00	1.85	2.33	2.14	2.32	1.97
53	6.65D	0.86	1.88	1.54	1.32	1.82	2.10	2.05	1.88	2.31	1.93	2.06	1.90	2.39	2.18	2.37	2.02
54	8.02D	0.88	1.86	1.53	1.31	1.81	2.08	2.04	1.87	2.30	1.92	2.06	1.89	2.39	2.18	2.37	2.03
55	9.57D	0.88	1.85	1.52	1.31	1.80	2.07	2.03	1.86	2.30	1.92	2.06	1.89	2.39	2.18	2.38	2.03
56	11.12D	0.88	1.82	1.51	1.30	1.78	2.06	2.01	1.85	2.28	1.90	2.05	1.88	2.38	2.17	2.38	2.02
57	12.67D	0.88	1.80	1.50	1.28	1.77	2.04	2.00	1.83	2.26	1.89	2.03	1.87	2.36	2.06	2.37	2.00

Table 9

Average Piezometer Readings, Type 8 Expansion

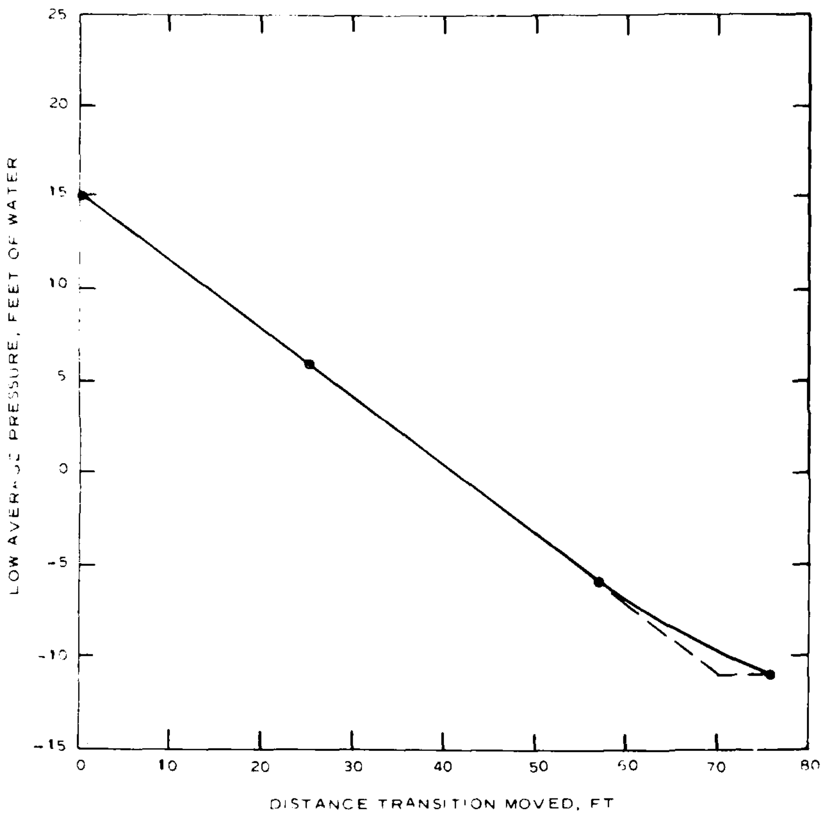
Piezometer Locations			Run Number*														
No.	Station	Elevation	433	434	435	436	437	438	439	440	441	442	443	444	445	446	447
4	15.00U	0.56	3.16	4.16	4.87	2.37	3.32	4.45	2.56	2.98	4.03	4.29	2.36	2.94	3.61	4.00	2.27
5	8.79U		3.13	4.13	4.83	2.33	3.26	4.37	2.51	2.88	3.88	4.11	2.25	2.78	3.43	3.80	2.11
6	6.75U		3.12	4.12	4.82	2.31	3.24	4.35	2.49	2.85	3.84	4.09	2.20	2.75	3.39	3.75	2.08
7	4.79U		3.11	4.11	4.81	2.30	3.22	4.34	2.47	2.83	3.83	4.07	2.19	2.72	3.36	3.72	2.05
8	2.79U		3.10	4.11	4.80	2.29	3.21	4.33	2.45	2.81	3.88	4.04	2.17	2.70	3.31	3.70	2.03
9	1.79U		3.09	4.09	4.79	2.28	3.19	4.30	2.42	2.78	3.77	3.99	2.13	2.65	3.30	3.64	1.98
14	0.08D		0.30	0.51	0.28	0.30	-0.35	-0.27	-0.02	-0.42	-0.43	-0.74	-0.57	-0.78	-0.85	-0.86	-0.38
15	0.22D		0.29	0.49	0.30	0.29	-0.37	-0.29	0.00	-0.46	-0.45	-0.75	-0.58	-0.77	-0.84	-0.88	-0.40
16	0.36D		0.29	0.51	0.28	0.30	-0.35	-0.27	-0.02	-0.42	-0.43	-0.74	-0.58	-0.78	-0.85	-0.86	-0.38
17	0.50D		0.30	0.52	0.31	0.31	-0.33	-0.30	0.03	-0.40	-0.42	-0.72	-0.57	-0.77	-0.83	-0.85	-0.37
18	0.64D		0.31	0.53	0.33	0.32	-0.32	-0.26	0.05	-0.38	-0.40	-0.69	-0.55	-0.75	-0.79	-0.79	-0.34
19	0.78D		0.32	0.55	0.35	0.34	-0.29	-0.22	0.07	-0.36	-0.32	-0.63	-0.51	-0.66	-0.73	-0.70	-0.27
20	0.92D		0.33	0.57	0.37	0.36	-0.26	-0.18	0.10	-0.34	-0.29	-0.58	-0.48	-0.59	-0.65	-0.67	-0.22
21	1.06D		0.35	0.58	0.38	0.38	-0.22	-0.15	0.17	-0.29	-0.19	-0.47	-0.42	-0.48	-0.52	-0.52	-0.12
22	1.20D		0.37	0.63	0.42	0.41	-0.13	-0.05	0.25	-0.19	-0.05	-0.32	-0.24	-0.31	-0.29	-0.26	0.02
23	1.34D		0.39	0.66	0.46	0.45	-0.08	-0.02	0.32	-0.14	0.04	-0.23	-0.18	-0.17	-0.16	-0.03	0.13
24	1.48D		0.42	0.69	0.51	0.51	-0.02	0.10	0.41	-0.03	0.18	0.00	-0.05	-0.03	0.04	0.13	0.22
25	1.62D		0.45	0.74	0.56	0.56	0.07	0.22	0.45	0.13	0.30	0.17	0.04	0.10	0.21	0.28	0.33
26	1.76D		0.49	0.78	0.63	0.61	0.12	0.31	0.50	0.23	0.39	0.33	0.17	0.16	0.36	0.43	0.42
27	1.90D		0.52	0.85	0.71	0.65	0.19	0.39	0.59	0.32	0.56	0.50	0.27	0.31	0.48	0.61	0.51
28	2.04D		0.57	0.92	0.81	0.71	0.32	0.56	0.66	0.44	0.76	0.61	0.38	0.44	0.61	0.72	0.59
29	2.18D		0.62	0.96	0.87	0.76	0.35	0.60	0.73	0.47	0.81	0.72	0.44	0.51	0.67	0.78	0.64
30	2.32D	0.57	0.68	1.04	1.03	0.80	0.41	0.71	0.81	0.56	0.92	0.83	0.51	0.59	0.86	0.96	0.72
31	2.46D	0.58	0.75	1.14	1.14	0.89	0.53	0.89	0.86	0.65	1.06	0.93	0.61	0.68	0.96	1.07	0.75
32	2.60D	0.60	0.77	1.18	1.18	0.94	0.64	0.96	0.88	0.71	1.11	0.97	0.66	0.73	1.02	1.13	0.79
33	2.74D	0.61	0.83	1.23	1.24	0.97	0.73	1.07	0.94	0.81	1.16	1.05	0.68	0.87	1.06	1.23	0.83
34	2.88D	0.62	0.90	1.30	1.31	0.99	0.77	1.15	1.02	0.89	1.28	1.21	0.73	0.91	1.12	1.30	0.88
35	3.02D	0.64	0.93	1.33	1.34	1.02	0.81	1.23	1.04	0.92	1.34	1.25	0.76	0.94	1.17	1.36	0.91
36	3.16D	0.65	0.95	1.36	1.37	1.04	0.83	1.26	1.07	0.95	1.39	1.30	0.77	0.98	1.25	1.41	0.93
37	3.30D	0.67	0.98	1.45	1.44	1.06	0.86	1.34	1.11	1.01	1.46	1.35	0.80	1.02	1.33	1.50	0.97
38	3.44D	0.68	1.01	1.47	1.50	1.08	0.89	1.39	1.14	1.06	1.51	1.41	0.83	1.05	1.35	1.53	1.00
39	3.58D	0.69	1.03	1.49	1.55	1.10	0.94	1.46	1.16	1.10	1.56	1.50	0.87	1.09	1.39	1.62	1.02
40	3.72D	0.71	1.05	1.51	1.57	1.10	0.97	1.48	1.19	1.12	1.59	1.54	0.89	1.12	1.42	1.65	1.03
41	3.86D	0.72	1.06	1.54	1.60	1.10	1.00	1.50	1.21	1.14	1.63	1.59	0.91	1.13	1.44	1.70	1.06
42	4.00D	0.74	1.07	1.57	1.62	1.10	1.03	1.52	1.23	1.15	1.65	1.63	0.93	1.15	1.48	1.73	1.08
43	4.14D	0.75	1.09	1.59	1.64	1.11	1.05	1.54	1.25	1.17	1.67	1.65	0.95	1.18	1.51	1.77	1.10
44	4.28D	0.76	1.10	1.61	1.66	1.12	1.07	1.56	1.27	1.19	1.71	1.68	0.97	1.20	1.53	1.79	1.11
45	4.42D	0.78	1.11	1.62	1.68	1.13	1.09	1.58	1.29	1.20	1.73	1.71	0.98	1.22	1.55	1.83	1.12
46	4.70D	0.81	1.11	1.63	1.69	1.13	1.10	1.61	1.31	1.22	1.75	1.74	1.00	1.24	1.59	1.86	1.14
47	4.98D	0.83	1.12	1.64	1.70	1.14	1.11	1.63	1.33	1.23	1.77	1.77	1.02	1.27	1.62	1.89	1.16
48	5.26D	0.86	1.13	1.65	1.71	1.15	1.12	1.64	1.35	1.25	1.79	1.79	1.04	1.29	1.65	1.92	1.18
54	8.02D	0.88	1.12	1.64	1.71	1.14	1.12	1.66	1.33	1.27	1.81	1.80	1.06	1.31	1.67	1.93	1.21
55	9.58D	0.88	1.12	1.64	1.70	1.13	1.11	1.65	1.32	1.26	1.80	1.79	1.05	1.30	1.66	1.92	1.20
56	11.14D	0.88	1.12	1.63	1.70	1.13	1.10	1.64	1.31	1.25	1.79	1.78	1.04	1.29	1.65	1.91	1.19
57	12.70D	0.88	1.12	1.63	1.70	1.13	1.10	1.64	1.31	1.24	1.78	1.77	1.03	1.28	1.64	1.90	1.18

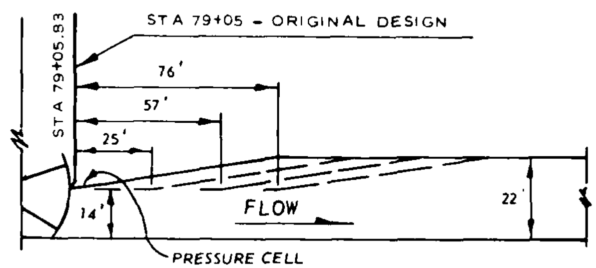
(Continued)

* Refer to Table 1 for flow conditions for each run.

Table 9 (Concluded)

Piezometer Locations			Run Number														
No.	Station	Elevation	448	449	463	462	461	451	452	453	454	455	456	457	458	459	460
4	15.00U	0.56	2.64	3.29	3.14	2.52	2.24	1.88	2.40	3.55	3.59	1.59	2.45	3.24	2.22	2.58	2.87
5	8.79U		2.47	3.11	2.91	2.37	2.11	1.73	2.19	3.33	3.36	1.44	2.34	2.98	1.91	2.28	2.56
6	6.75U		2.43	3.05	2.89	2.33	2.08	1.70	2.14	3.26	3.29	1.41	2.30	2.92	1.86	2.22	2.48
7	4.79U		2.42	3.03	2.85	2.31	2.06	1.68	2.11	3.23	3.25	1.38	2.27	2.88	1.82	2.16	2.42
8	2.79U		2.39	3.01	2.82	2.28	2.04	1.67	2.08	3.20	3.22	1.37	2.25	2.86	1.80	2.14	2.40
9	1.79U		2.36	2.95	2.73	2.22	1.98	1.63	2.00	3.11	3.12	1.30	2.16	2.76	1.72	2.03	2.27
14	0.08D		-0.38	-1.10	-1.33	-0.75	-0.41	-0.44	-1.05	-0.24	-0.62	-0.46	-0.58	-0.60	0.35	0.25	0.35
15	0.22D		-0.40	-1.12	-1.41	-0.85	-0.57	-0.45	-1.06	-0.23	-0.60	-0.45	-0.57	-0.55	0.32	0.23	0.28
16	0.36D		-0.38	-1.10	-1.44	-0.93	-0.59	-0.44	-1.05	-0.26	-0.57	-0.43	-0.55	-0.50	0.36	0.38	0.41
17	0.50D		-0.34	-1.12	-1.43	-0.92	-0.57	-0.43	-1.03	-0.22	-0.53	-0.38	-0.53	-0.41	0.59	0.65	0.64
18	0.64D		-0.32	-1.08	-1.36	-0.87	-0.55	-0.37	-1.00	-0.18	-0.44	-0.32	-0.40	-0.30	0.76	0.84	0.93
19	0.78D		-0.24	-1.02	-1.30	-0.81	-0.48	-0.29	-0.82	-0.04	-0.30	-0.22	-0.24	-0.11	0.91	1.07	1.16
20	0.92D		-0.19	-0.88	-1.26	-0.75	-0.42	-0.20	-0.70	0.16	-0.08	-0.08	-0.04	0.18	1.06	1.23	1.43
21	1.06D		-0.05	-0.74	-1.11	-0.62	-0.33	-0.07	-0.63	0.29	0.05	0.02	0.10	0.05	1.16	1.32	1.51
22	1.20D		0.03	-0.40	-0.83	-0.44	-0.14	0.10	-0.28	0.60	0.41	0.18	0.40	0.65	1.21	1.47	1.57
23	1.34D		0.13	-0.25	-0.64	-0.36	-0.03	0.17	-0.18	0.74	0.58	0.26	0.51	0.82	1.23	1.42	1.63
24	1.48D		0.25	0.00	-0.42	-0.17	0.11	0.30	0.00	1.01	0.85	0.37	0.67	1.02	1.25	1.44	1.66
25	1.62D		0.38	0.21	-0.16	0.00	0.21	0.41	0.21	1.17	0.96	0.42	0.78	1.16	1.27	1.46	1.68
26	1.76D		0.54	0.34	0.03	0.15	0.34	0.48	0.34	1.27	1.07	0.46	0.87	1.24	1.29	1.48	1.70
27	1.90D		0.62	0.46	0.19	0.25	0.43	0.55	0.42	1.38	1.19	0.49	0.92	1.28	1.28	1.48	1.71
28	2.04D		0.69	0.67	0.28	0.37	0.49	0.58	0.51	1.43	1.30	0.52	0.97	1.33	1.27	1.46	1.70
29	2.18D		0.75	0.72	0.47	0.45	0.56	0.61	0.53	1.46	1.34	0.53	0.98	1.36	1.24	1.42	1.65
30	2.32D	0.57	0.84	0.78	0.56	0.54	0.62	0.64	0.55	1.54	1.39	0.56	1.03	1.42	1.27	1.46	1.69
31	2.46D	0.58	0.92	0.88	0.61	0.63	0.68	0.68	0.64	1.61	1.48	0.61	1.11	1.50	1.34	1.55	1.80
32	2.60D	0.60	0.95	0.93	0.70	0.67	0.72	0.71	0.68	1.66	1.56	0.64	1.16	1.56	1.39	1.60	1.86
33	2.74D	0.61	1.02	1.02	0.81	0.73	0.75	0.76	0.74	1.72	1.61	0.67	1.20	1.62	1.42	1.65	1.91
34	2.88D	0.62	1.07	1.11	0.86	0.77	0.79	0.80	0.81	1.78	1.67	0.71	1.26	1.67	1.45	1.70	1.94
35	3.02D	0.64	1.10	1.17	0.91	0.79	0.83	0.83	0.84	1.81	1.71	0.72	1.28	1.73	1.48	1.73	1.97
36	3.16D	0.65	1.12	1.20	0.94	0.84	0.86	0.86	0.88	1.85	1.74	0.75	1.33	1.78	1.51	1.78	2.02
37	3.30D	0.67	1.15	1.24	0.97	0.88	0.89	0.88	0.93	1.91	1.78	0.78	1.36	1.80	1.53	1.80	2.05
38	3.44D	0.68	1.17	1.30	1.01	0.93	0.93	0.90	0.97	1.94	1.83	0.80	1.39	1.85	1.56	1.84	2.10
39	3.58D	0.69	1.20	1.33	1.03	0.96	0.95	0.92	0.99	1.98	1.88	0.82	1.41	1.87	1.59	1.87	2.12
40	3.72D	0.71	1.25	1.36	1.05	0.97	0.97	0.93	1.02	2.02	1.91	0.83	1.42	1.90	1.62	1.90	2.15
41	3.86D	0.72	1.28	1.38	1.08	1.01	0.99	0.94	1.04	2.05	1.95	0.84	1.44	1.94	1.62	1.93	2.17
42	4.00D	0.74	1.31	1.40	1.11	1.03	1.02	0.96	1.07	2.09	1.99	0.86	1.47	1.96	1.66	1.95	2.20
43	4.14D	0.75	1.33	1.42	1.16	1.04	1.04	0.98	1.09	2.11	2.03	0.87	1.50	1.99	1.67	1.97	2.22
44	4.28D	0.76	1.35	1.44	1.19	1.05	1.06	1.00	1.12	2.14	2.06	0.89	1.53	2.03	1.69	2.00	2.25
45	4.42D	0.78	1.38	1.46	1.23	1.07	1.08	1.02	1.14	2.17	2.10	0.91	1.56	2.06	1.71	2.04	2.25
46	4.70D	0.81	1.40	1.51	1.26	1.11	1.10	1.03	1.17	2.19	2.14	0.93	1.60	2.10	1.74	2.07	2.33
47	4.98D	0.83	1.42	1.54	1.30	1.14	1.13	1.05	1.20	2.22	2.19	0.96	1.63	2.15	1.77	2.14	2.41
48	5.26D	0.86	1.43	1.58	1.34	1.17	1.15	1.07	1.23	2.28	2.24	0.98	1.66	2.21	1.80	2.17	2.42
54	8.02D	0.88	1.44	1.61	1.35	1.19	1.14	1.08	1.25	2.30	2.23	1.16	1.83	2.08	1.79	2.16	2.45
55	9.58D	0.88	1.43	1.60	1.34	1.18	1.13	1.08	1.24	2.22	2.18	1.20	1.79	2.02	1.78	2.19	2.41
56	11.14D	0.88	1.42	1.59	1.33	1.17	1.12	1.07	1.23	2.30	2.27	1.12	1.82	2.07	1.77	2.29	2.50
57	12.70D	0.88	1.41	1.58	1.32	1.16	1.11	1.06	1.22	2.28	2.25	1.15	1.83	2.08	1.78	2.29	2.50





ROOF TRANSITION POSITIONS

NOTE: PRESSURES OBTAINED WITH FLUSH-MOUNTED PRESSURE CELL
PLOTTED POINTS ARE AVERAGES OF 5 RUNS

FROM NPD TR NO. 126-1

EFFECT OF ROOF TRANSITION ON PRESSURE AT FILLING VALVE LOWER GRANITE LOCK

1.11-MIN VALVE SCHEDULE
TWO-VALVE OPERATION, 105-FT INITIAL HEAD

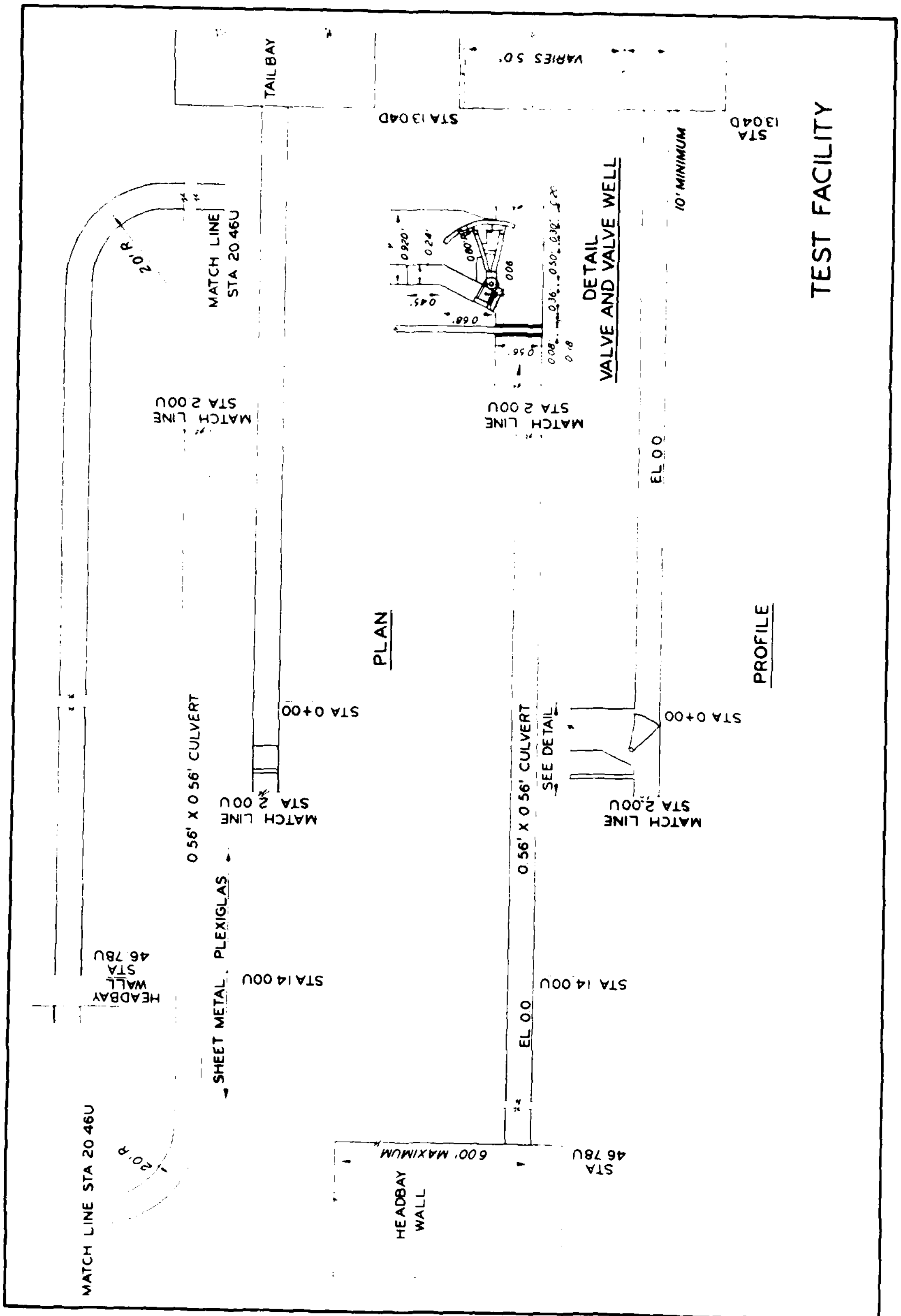
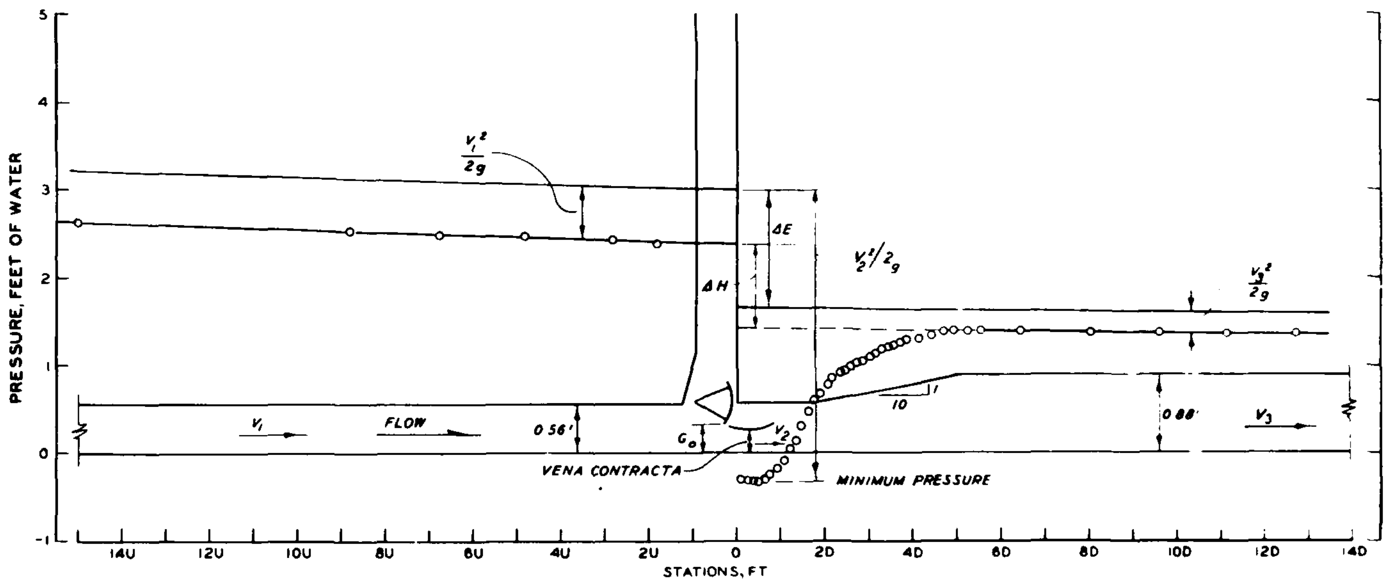
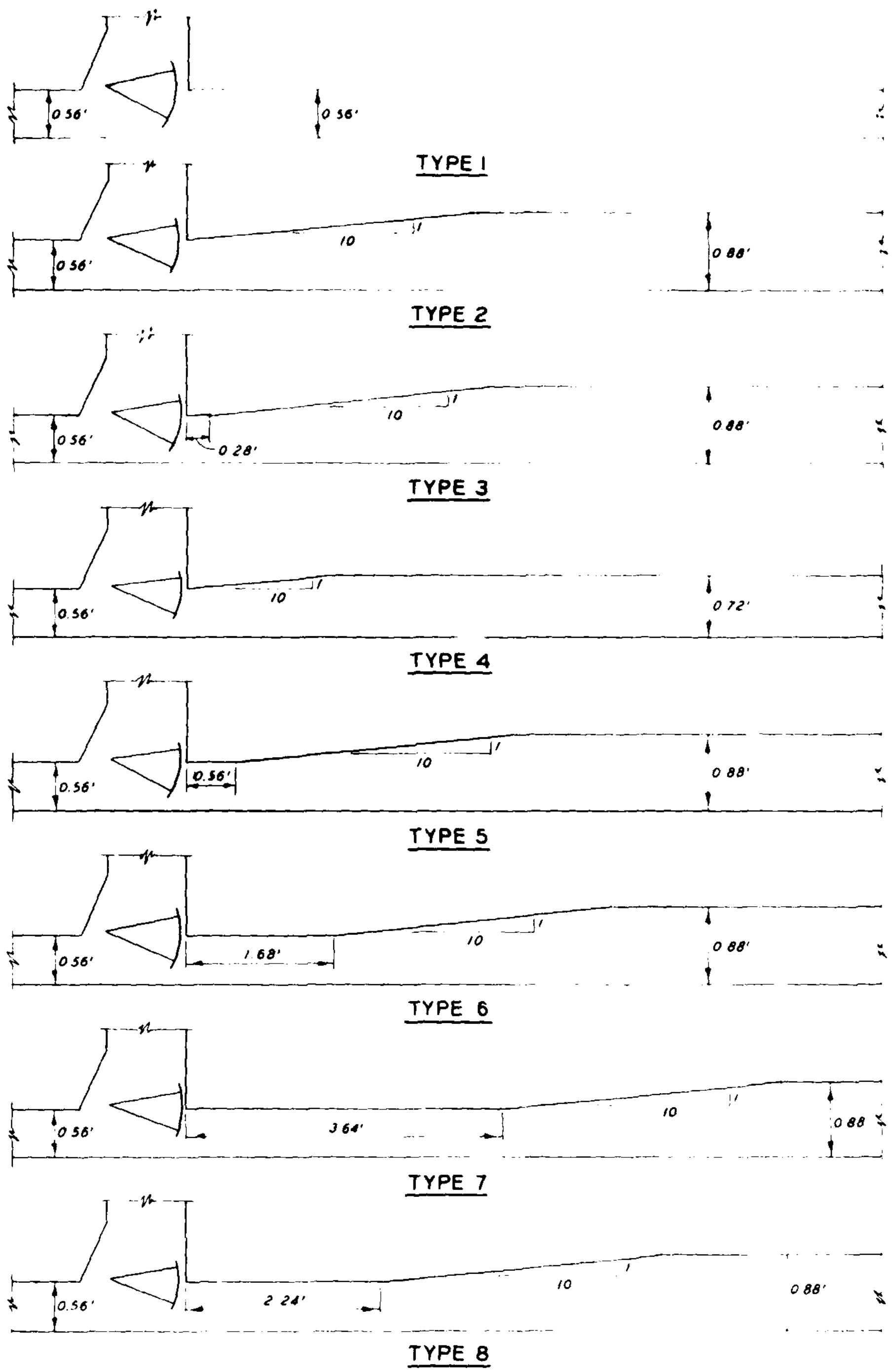

TEST FACILITY
PLAN
PROFILE
DETAIL
VALVE AND VALVE WELL
TAIL BAY
VARIES 5.0'
STA 13.04D
10' MINIMUM
MATCH LINE STA 20.46U
20' R
MATCH LINE STA 2.00U
EL 0.0
STA 0+00
0.56' X 0.56' CULVERT
SEE DETAIL
SHEET METAL, PLEXIGLAS
STA 14.00U
HEADBAY WALL
STA 46.78U
6.00' MAXIMUM

PLATE 2



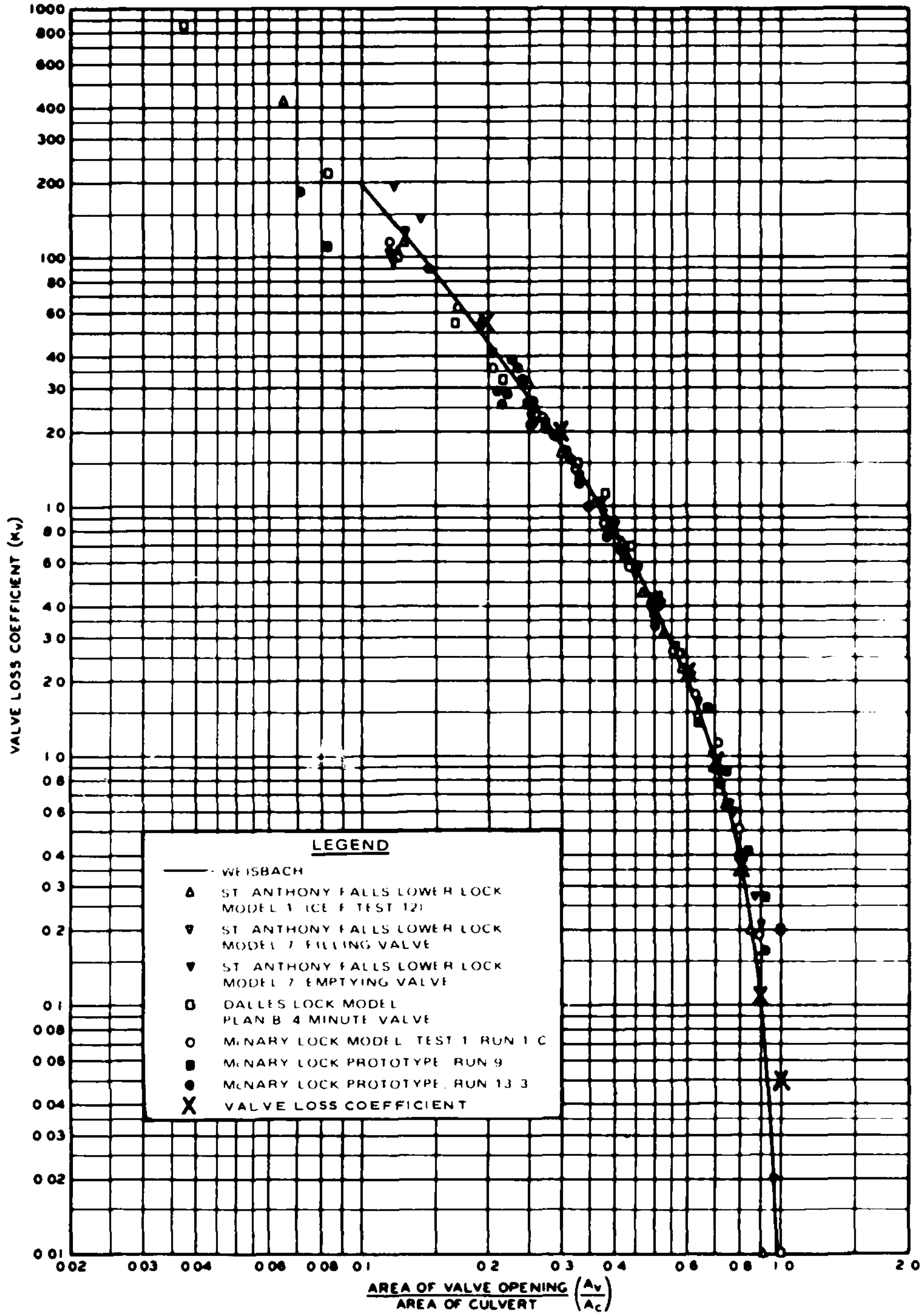
TYPICAL DATA REDUCTION PLOT

RUN NUMBER 384
DISCHARGE 1.92 CFS
VALVE OPEN 60 PERCENT
TYPE 6 DESIGN



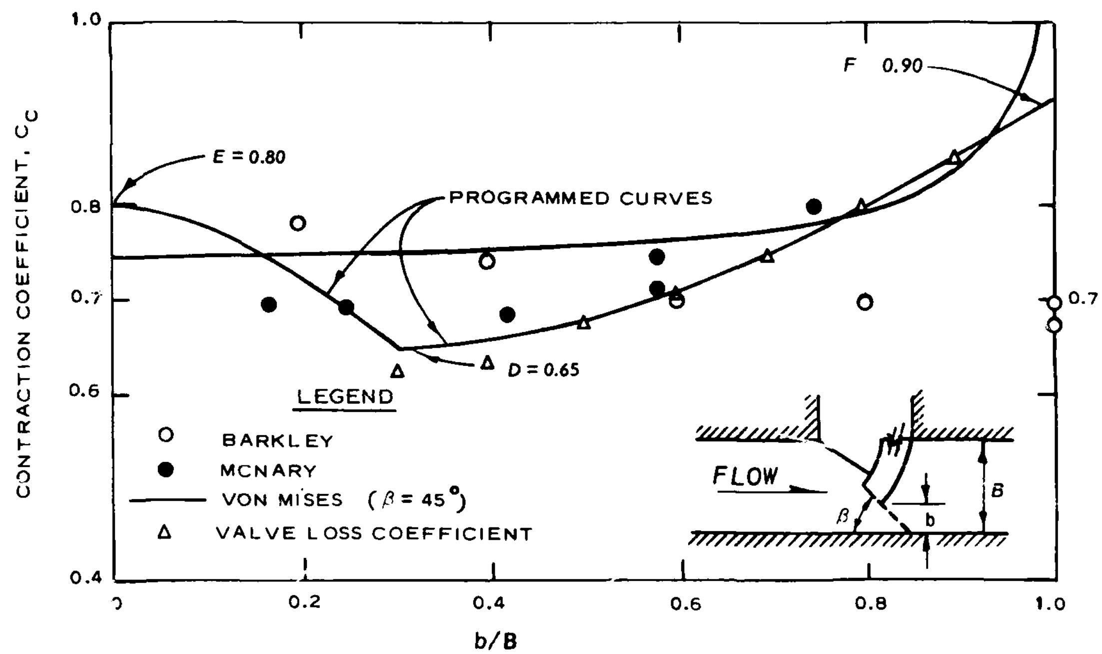
CULVERT EXPANSIONS

PLATE 4



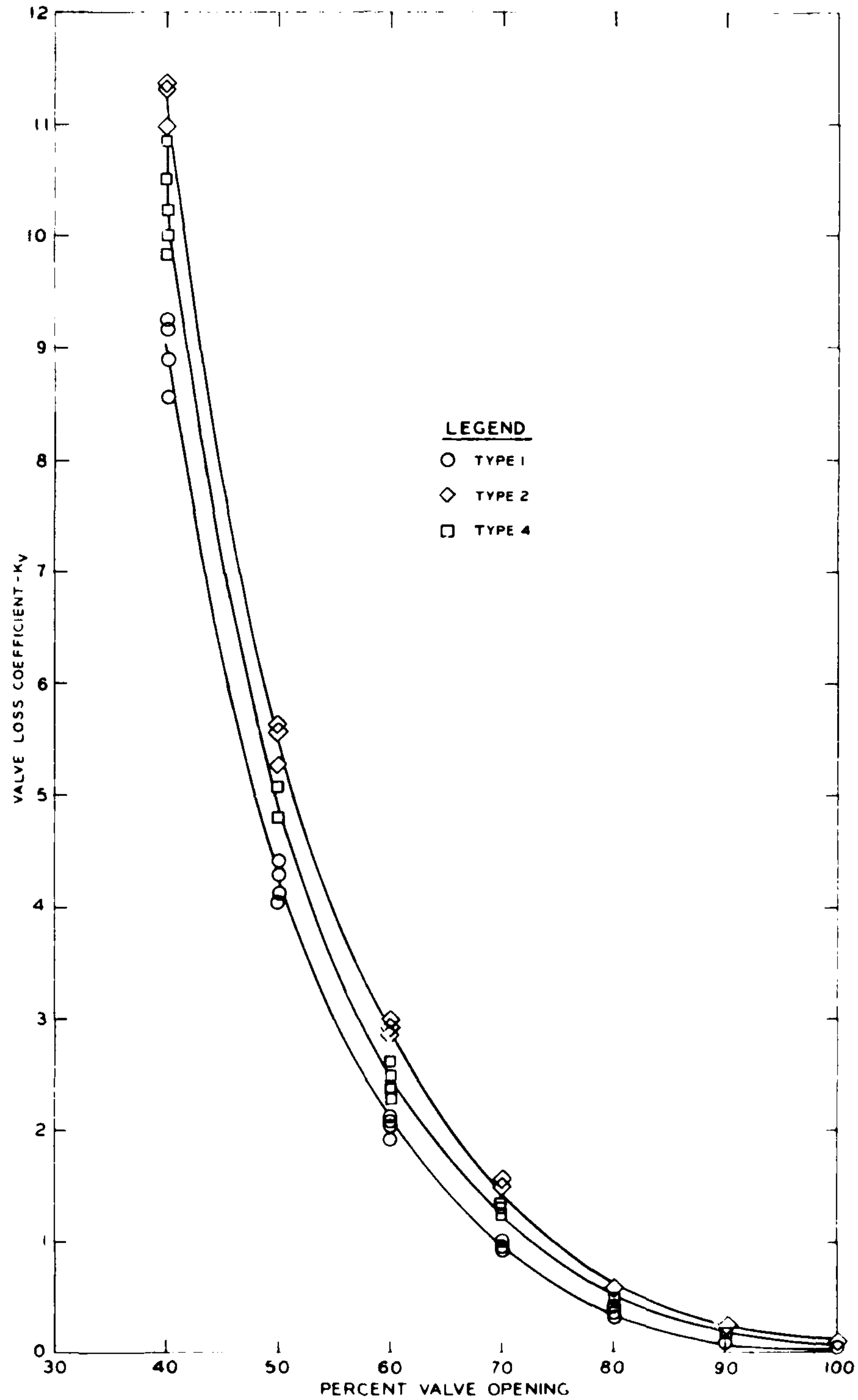
FROM HYDRAULIC DESIGN CHART 534-1

VALVE LOSS COEFFICIENTS UNEXPANDED CULVERTS

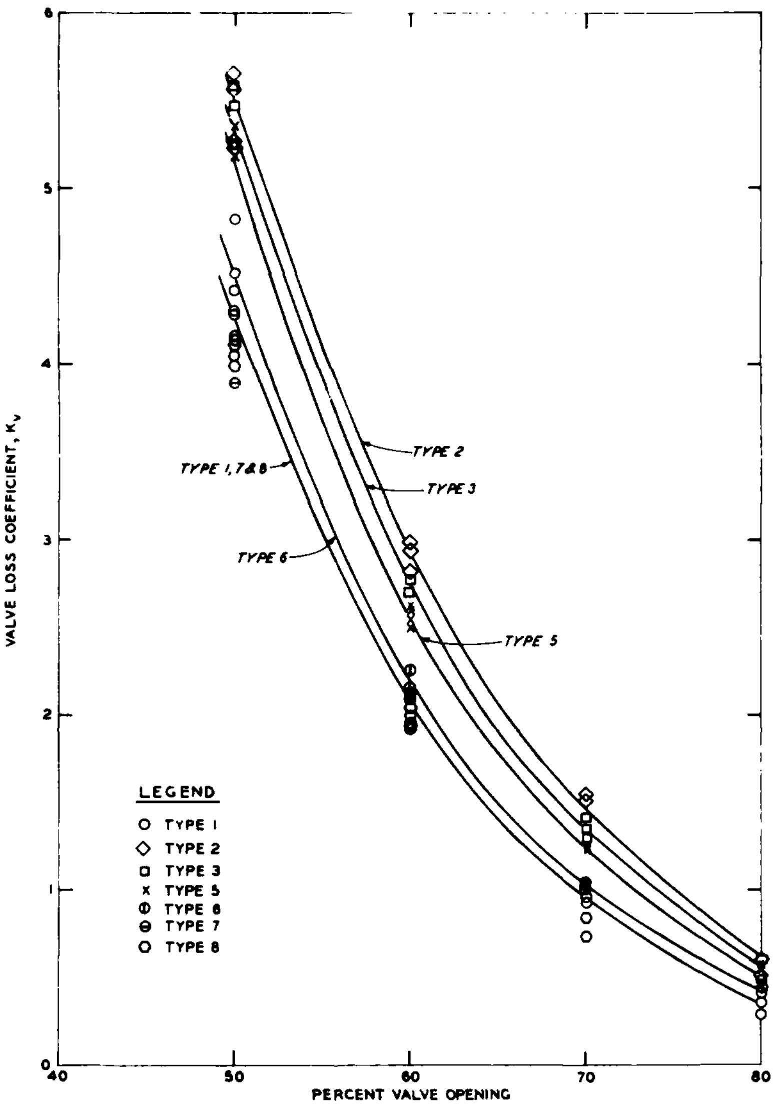


FROM EM 1110-2-1610

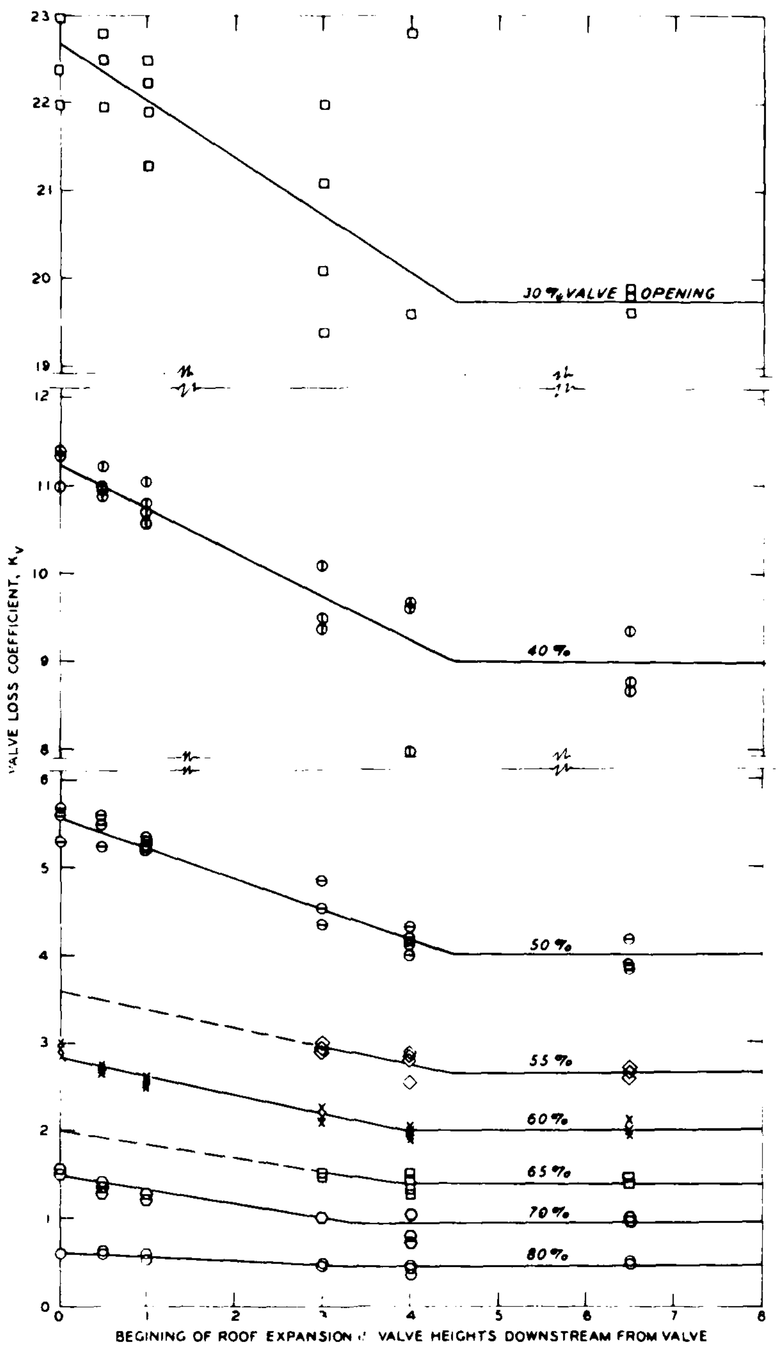
REVERSE TAINTER VALVE
CONTRACTION COEFFICIENT



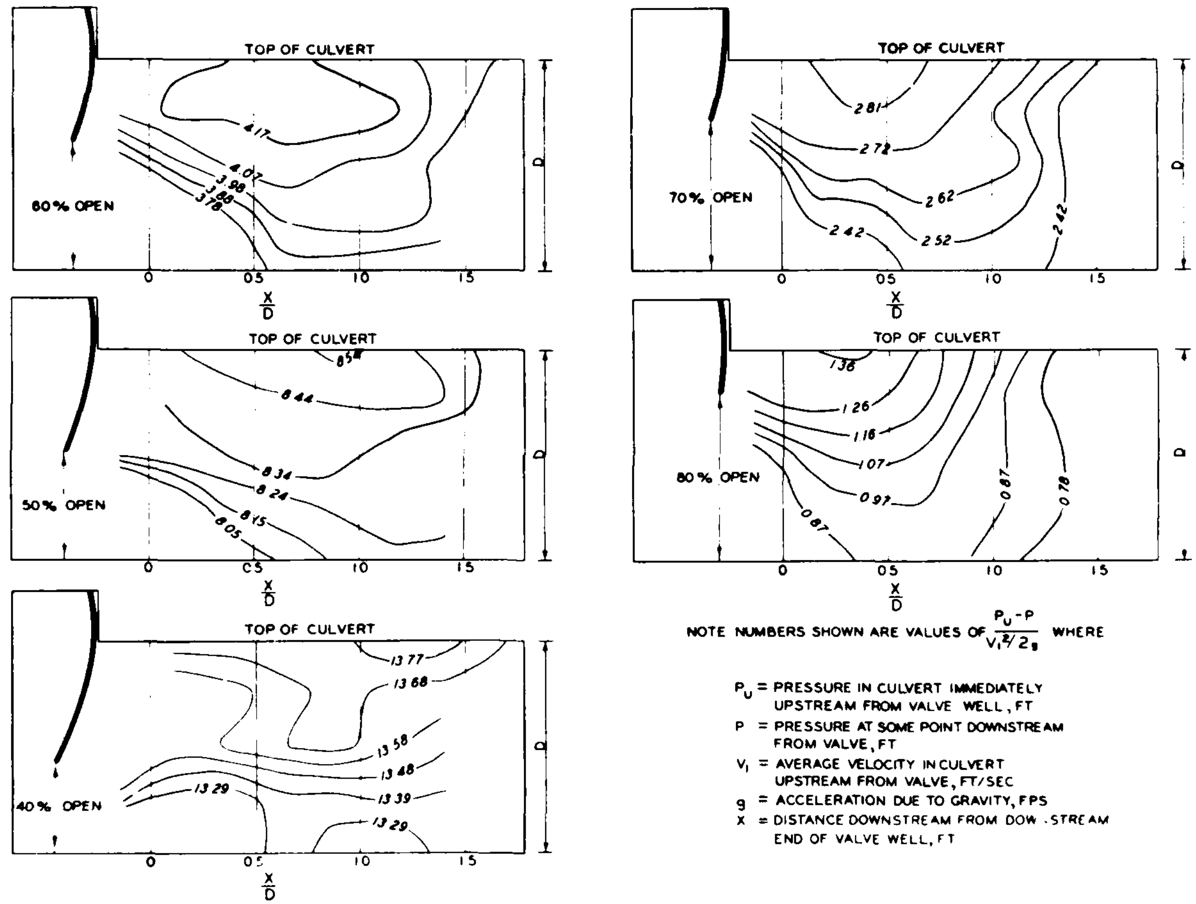
EFFECT OF CULVERT EXPANSIONS ON VALVE LOSS COEFFICIENTS



EFFECT OF CULVERT
EXPANSION LOCATION ON
VALVE LOSS COEFFICIENTS



EFFECT OF ROOF EXPANSION BEGINNING
ON VALVE LOSS COEFFICIENTS



NOTE NUMBERS SHOWN ARE VALUES OF $\frac{P_U - P}{V_1^2/2g}$ WHERE

P_U = PRESSURE IN CULVERT IMMEDIATELY UPSTREAM FROM VALVE WELL, FT

P = PRESSURE AT SOME POINT DOWNSTREAM FROM VALVE, FT

V_1 = AVERAGE VELOCITY IN CULVERT UPSTREAM FROM VALVE, FT/SEC

g = ACCELERATION DUE TO GRAVITY, FPS

X = DISTANCE DOWNSTREAM FROM DOWNSTREAM END OF VALVE WELL, FT

ISOPIESTIC LINES

In accordance with letter from DAEN-RDC, DAEN-ASI dated 22 July 1977, Subject: Facsimile Catalog Cards for Laboratory Technical Publications, a facsimile catalog card in Library of Congress MARC format is reproduced below.

Pickering, Glenn A.
  Lock culvert valve loss coefficients : hydraulic laboratory investigation / by Glenn A. Pickering (Hydraulics Laboratory, U.S. Army Engineer Waterways Experiment Station). -- Vicksburg, Miss. : The Station ; Springfield, Va. ; available from NTIS, 1981.
  15, [21] p., 10 p. of plates : ill. ; 27 cm. -- (Technical report / U.S. Army Engineer Waterways Experiment Station ; HL-81-10)
  Cover title.
  "September 1981."
  Final report.
  "Prepared for Office, Chief of Engineers, U.S. Army."
  1. Culverts. 2. Locks (Hydraulic engineering). 3. Pressure--Measurement. 4. Valves. I. United States. Army. Corps of Engineers. Office of the Chief of Engineers. II. U.S. Army Engineer Waterways Experiment Station. Hydraulics Laboratory. III. Title .V. Series: Technical report (U.S. Army Engineer Waterways Experiment Station) ; HL-81-10.
TA7.W34 no.HL-81-10

FILMED

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